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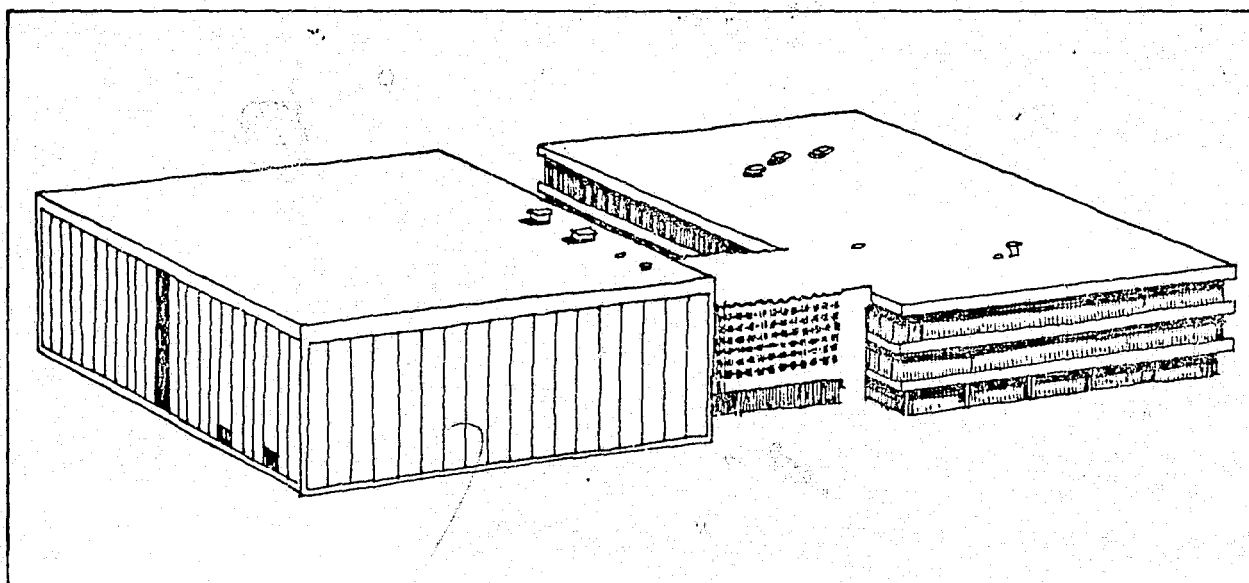
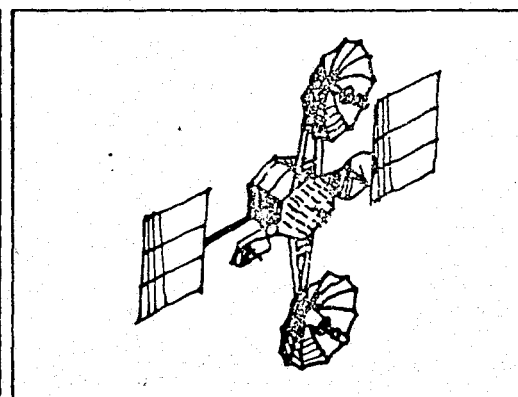
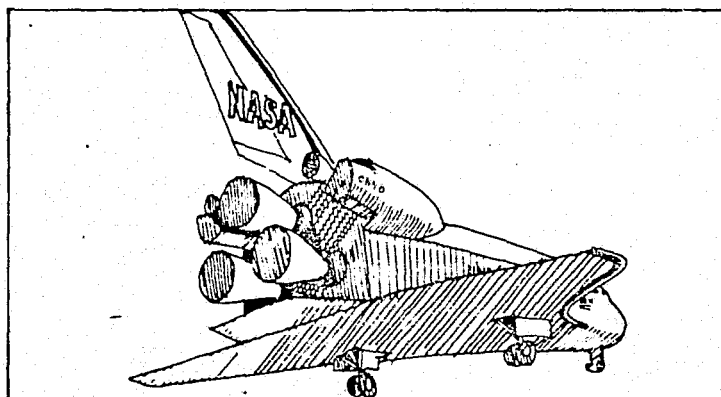
Mission Control Center (MCC) System Specification for the Shuttle Orbital Flight Test (OFT) Timeframe

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MISSION CONTROL CENTER (MCC) SYSTEM
SPECIFICATION FOR THE SHUTTLE
ORBITAL FLIGHT TEST (OFT) TIMEFRAME

Prepared for
GROUND DATA SYSTEMS DIVISION
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS

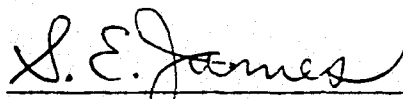
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Aeronutronic Ford Corporation (NAS 9-1261)
Federal Systems Division, International
Business Machines Corporation (NAS 9-14350)

Approved by

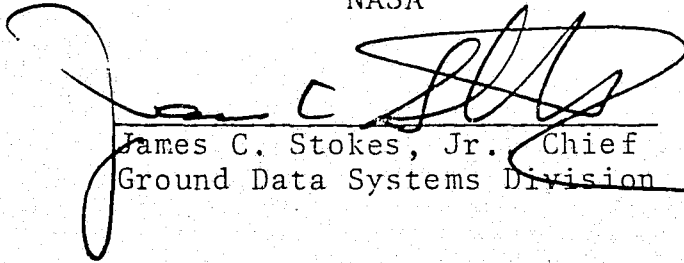
SISO

IBM


R. E. Cutchen
Manager, JSC Programs


S. E. James, Project Manager
Ground Based Space Systems

NASA


James C. Stokes, Jr. Chief
Ground Data Systems Division

AERONUTRONIC FORD CORPORATION
AERO-COMM ENGINEERING SERVICES DIVISION
SPACE INFORMATION SYSTEMS OPERATION
1002 GEMINI AVENUE, HOUSTON, TEXAS

FOREWORD

This document is developed jointly by the Lyndon B. Johnson Space Center, Houston, Texas, Ground Data Systems Division; Aeronutronic Ford Corporation; and IBM/Houston. It is published by Aeronutronic Ford Corporation in accordance with the requirements established under Schedule V, Modification No. 202 to Contract NAS 9-1261, Task Order (TO) P-1B00.

This document defines the current level of completion of the Orbital Flight Test Data System (OFTDS) design that is baselined to date. Sections of the Level A Requirements Document that have not yet been written into this document include: Support System Models, Computer Systems Operations, Software Development Tools, and Offline Applications Programs. These and other subsections marked with a TBS (to be supplied) shall be defined in the final revision of this document currently scheduled for 24 May 1976. Any information required pertaining to specification development may be acquired from the *MCC Shuttle Development Plan*, JSC-10001.

Aeronutronic 

Aeronutronic Ford Corporation
Space Information Systems Operation

1002 Gemini Avenue
Houston, Texas 77058

JSC-10013

MISSION CONTROL CENTER (MCC) SYSTEM
SPECIFICATION FOR THE SHUTTLE
ORBITAL FLIGHT TEST (OFT) TIMEFRAME

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WRITER <i>B.G. Hart</i>	DATE <i>2, 20, 76</i>	APPROVAL	DATE
APPROVAL		MGR, MCC SHUTTLE	
COGNIZANT ENGR: <i>J.E. Hite</i>	<i>2, 17, 76</i>	PROGRAM: <i>C.F. Dooling</i>	<i>2, 20, 76</i>
SUPVR, SYSTEMS		MGR, SYSTEM ENGINEERING	
ANALYSIS: <i>D.O. Norman</i>	<i>2, 17, 76</i>	ACTIVITY: <i>Rev. C.R. Hite</i>	<i>2, 17, 76</i>
MGR, COMPUTER SYSTEMS		MGR, SYSTEMS	
DEPT: <i>C.H. Dooling</i>	<i>2, 17, 76</i>	RELIABILITY: <i>A.L. Patterson</i>	<i>2, 17, 76</i>
MGR, EQUIPMENT ENGINEERING		MGR, QUALITY	
DEPT: <i>Lee C. Hite</i>	<i>2, 17, 76</i>	ASSURANCE: <i>B. Hankins</i>	<i>2, 23, 76</i>
MGR, SOFTWARE SYSTEMS		SUPVR, TECHNICAL	
DEPT: <i>H. Johnson</i>	<i>2, 17, 76</i>	PUBLICATIONS: <i>D. J. Hite</i>	<i>2, 26, 76</i>
MGR, MCC SHUTTLE DATA SYSTEM		RELEASE	
PROGRAM <i>R.E. Gandy</i>	<i>2, 20, 76</i>	DATE <i>CR 2/26</i>	PAGE 1 OF 406

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1. SCOPE

1.1 General. This document specifies the Johnson Space Center's (JSC) Mission Control Center (MCC) systems required to monitor and control Shuttle orbital test flights.

This document defines MCC systems, both hardware and software, their configurations, and the extent of their implementation to be accomplished for the Orbital Flight Test (OFT) timeframe. The OFT timeframe is considered to be through the sixth OFT flight. This specification, therefore, includes certain implementations and transition requirements that must occur to keep the MCC functionally ready for all phases of the Space Transportation System (STS) Program.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed below were used as source material in the generation of this specification. These documents are listed only as references, and do not constitute a portion of the design contained within this document. Where discrepancies exist between this document and the references listed below, this document shall take precedence.

- a. *Shuttle Telemetry Standards*, Vol. XIV, Appendix A-X, 18 March 1975, NASA JSC.
- b. *ALT OI Data*, JSC Memorandum.
- c. SI-2582D, *Preliminary ALT Interface Control Document*, SISO.
- d. SE-25818, *Preliminary ALTDS Hardware Performance Specification*, SISO.
- e. SH-25819, *Preliminary ALTDS Software Design*, 7 August 1975, SISO.
- f. "Network Interface Processor Study", SISO MCC Task 3 Study Report, 7 April 1975, SISO.

2.1 General. (Continued)

- g. JSC-09337, *Space Shuttle Orbiter Approach and Landing Test-Flight Operations Facilities Requirements*, 7 March 1975, NASA JSC.
- h. *Computer Program Development Specification (CPDS) - Vol. 1, Book 1, (Hardware) and Book 2 (Software)*, February 1975, SSD, DSAD, NASA JSC.
- i. MC615-0016, *Compiler - PCMMU Specification*, 15 February 1975.
- j. MF0004-038, *Assembler-MMD Specification*, 22 January 1975.
- k. MC476-1030A, *PCMMU Specification*, 12 November 1973.
- l. MC615-004B, *MDM Specification*, 11 December 1974.
- m. *Data Format Control Book(s) (ALT, OFT, OPS)*, GDSD NASA JSC.
- n. SS-09605, *Skylab Display Control System Requirements and Specification*, 9 September 1972.
- o. SISO-TR615, *Preliminary Network Interface Processor Requirements*, 7 July 1975, SISO.
- p. *Shuttle Telemetry Data Formats Control Book*, Rev. D, 10 March 1975, NASA JSC.
- q. *Level A Requirements for Shuttle*, Vol. I, OFT, 17 October 1975, NASA JSC.
- r. *OFT Baseline Operations Plan*, NASA JSC.
- s. GY28-6659, *IBM System/360 Operating System MVT Supervisor*, IBM.



2.1 General. (Continued)

- t. GY28-6660, *IBM System/360 Operating System: MVT Job Management, Program Logic Manual*, IBM.
- u. GY28-6658, *IBM System/360 Operating System: MVT Control Program Logic Summary, Program Logic Manual*, IBM.
- v. GY28-6661, *IBM System/360 Operating System Initial Program Loader and Nucleus Initialization Program*, IBM.
- w. GC28-5704, *IBM System/360 Operating System: Job Control Language Reference*, IBM.
- x. GY28-7199, *IBM System/360 Operating System Time Sharing Option (TSO) Control Program*, IBM.
- y. GY28-6607, *IBM System/360 Operating System Catalog Management Program Logic Manual*, IBM.
- z. GY28-6607, *OS DADSM Logic*, IBM.
- aa. GY28-6616, *OS I/O Supervisor Logic*, IBM.
- ab. GY28-6609, *OS OPEN/CLOSE/EOV Logic*, IBM.
- ac. GC28-6712, *OS SMF*, IBM.
- ad. GC28-6586, *OS Utilities*, IBM.
- ae. GC28-6708, *OS Advanced Checkpoint/Restart*, IBM.
- af. GC28-6514, *OS Assembler Language*, IBM.
- ag. GC28-6538, *IBM OS Linkage Editor and Loader*, IBM.
- ah. GC28-6817, *IBM System/360 Operating System FORTRAN IV (G and H) Programmers Guide*.

2.1 General. (Continued)

- ai. GC28-8201, *IBM System/360 Operating System PL/I (F) Language Reference Manual.*
- aj. GC28-3337, *IBM System/360 Operating System RPG Language Specifications.*
- ak. GC28-6399, *IBM OS Full American National Standard COBOL Compiler and Library, Version 2 Programmer's Guide.*
- al. Contract No. NAS 9-13861, *EOS User's Guide.*
- am. Contract No. NAS 9-13861, *EOS Program Documentation.*
- an. PHO-TR388, *PHO Operations Quality/Reliability Plan*, 12 September 1968; Rev. B, Ch. 1, 5 September 1975, SISO.
- ao. PHO-TR446, *DTE Background Disk Recording Program Requirements*, 6 May 1969, SISO.
- ap. PHO-TR576, *Study of Ground Data Handling Systems for Earth Resources Satellite*, 8 August 1974, SISO.
- aq. IS4000-00051, *SISO MCC Program General Requirements Specification*, SISO.
- ar. SE-09588, *DTE Cluster Control Unit Performance Specification*, 11 February 1971, SISO.
- as. SU-25827, *Confidence Tape Hardware Subsystem Performance Specification*, 13 June 1975, SISO.
- at. SP-25838, *Network Interface Processor Telemetry Preprocessor Computer System Procurement Specification*, 8 August 1975; Rev. A, 13 October 1975, SISO.
- au. PHO-TN321, *Reliability Baseline Analysis of the Video Display String Equipment*, SISO.
- av. *Generalized Confidence Tape System User's Guide*, SISO.

3. MCC SHUTTLE OFT SYSTEMS OVERVIEW

3.1 Introduction. The MCC Shuttle OFT System shall provide facilities for flight control and data systems personnel to monitor and control the Shuttle flights from launch (tower clear) to roll-out (wheels stopped on runway). It shall also support the preparation for flight (flight planning, flight controller and crew training, and integrated vehicle and network testing activities). The MCC Shuttle OFT System shall provide for monitoring and control of specific payloads assigned to JSC.

Emphasis during OFT shall be on the Shuttle system performance with extensive real-time system monitoring performed in the MCC to assure crew safety, mission success, and qualification of the Shuttle onboard systems. As the Shuttle becomes operational, the MCC support emphasis shall shift from basic systems monitoring to payload monitoring, data management, and multiple flight support.

The MCC Shuttle OFT System defined in this specification shall provide for all support requirements as defined in the *MCC Level A Requirements for Shuttle, Vol. 1: OFT*, dated 10 October 1975. General support requirements shall be as follows:

- Guidance, targeting, and command
- Trajectory determination and navigation
- Orbiter systems monitoring and command
- Trajectory monitoring and control
- Inflight data acquisition and data information extraction necessary for execution of above functions
- Communication
- MCC System development tools
- Simulation and training.

3.1 Introduction. (Continued)

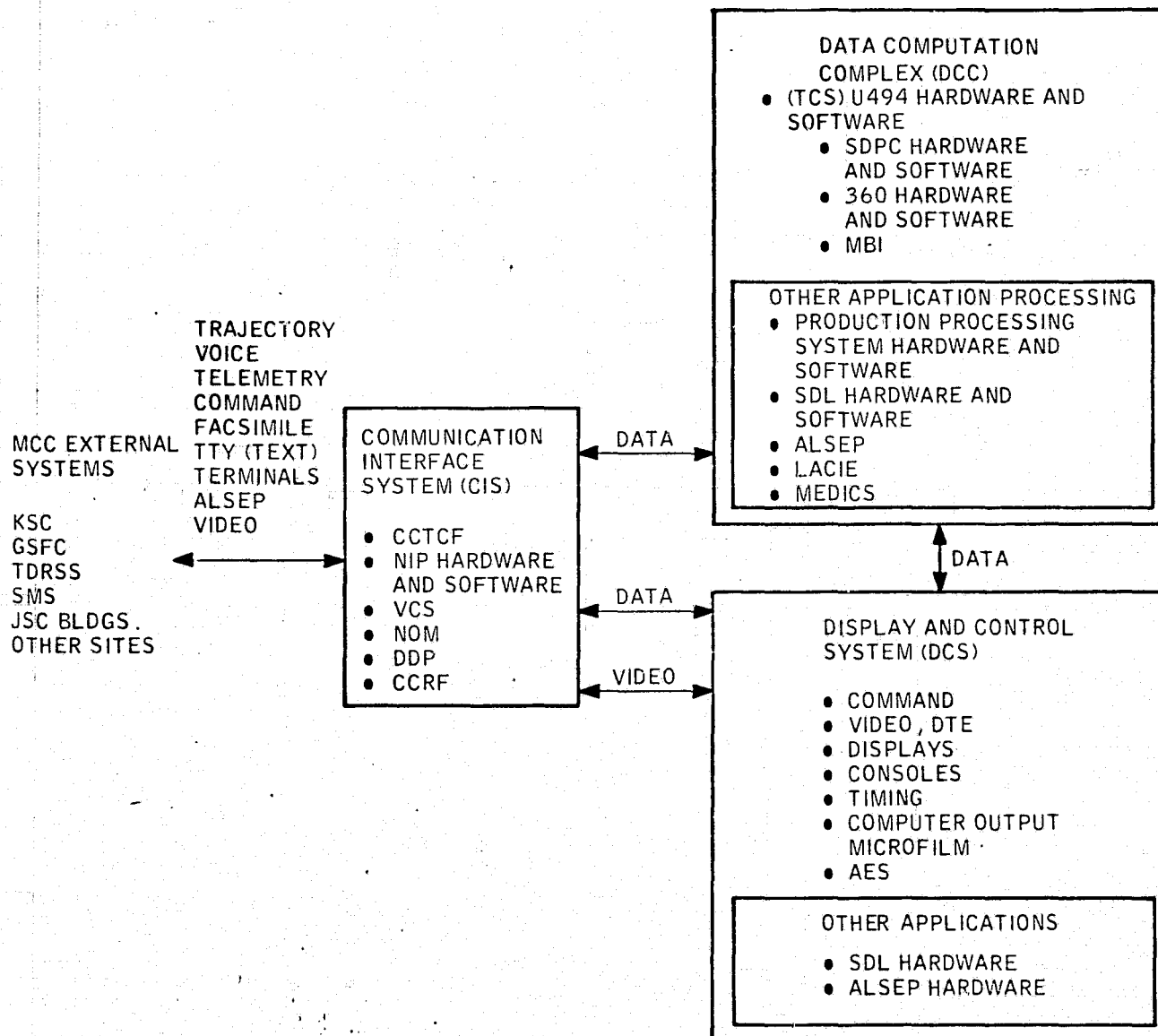
The MCC Shuttle OFT System configuration shall be based on three major support systems as shown in figure 1. These support systems are the Communication Interface System (CIS), the Data Computation Complex (DCC) and the Display and Control System (DCS), all of which may interface with, and share processing facilities with, other applications processing supporting current MCC programs. Other applications processing shall include:

- Software Development Lab (SDL)
- Large Area Crop Inventory Experiment (LACIE)
- Apollo Lunar Science Experiment Package (ALSEP)
- Production Processor System (PPS)
- Data Retrieval and Formatting Technique (DRAFT)
- Medical Information Computer System (MEDICS).

3.1.1 Purpose of the MCC. The MCC shall provide centralized control of the NASA Space Shuttle OFT from launch through orbital flight, entry, and landing until the Orbiter comes to a stop on the runway. This control shall include the functions of vehicle management in the area of hardware configuration (verification), flight planning, communication and instrumentation configuration management, trajectory, software and consumables; payloads management; flight safety; and verification of test conditions/environment.

3.1.2 Operations. The MCC shall be supported by the John F. Kennedy Space Center (KSC) facilities and by the Space Tracking Data Network (STDN).^{*} The STDN shall consist of a worldwide network of ground tracking and voice-data communication stations

^{*}Throughout this document, the term STDN shall be used to refer to the network of ground stations (remote sites) and to the TDRSS. Where it is necessary to differentiate between the two types of network elements, the term GSTDN or TDRSS shall be used.



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Figure 1 MCC Shuttle OFT Systems Overview

3.1.2 Operations. (Continued)

connecting with a Goddard Space Flight Center (GSFC) switching center, a Ground Satellite Tracking Data Network (GSTDN), and a Tracking and Data Relay Satellite System (TDRSS). The TDRSS is expected to reduce the GSTDN support required for Shuttle as it becomes operational. It shall consist of two satellites placed in a geosynchronous equatorial orbit to give maximum earth orbit coverage to spacecrafts at orbital altitudes up to approximately 2700 nmi (5000 km), and one primary ground station, optimally located for viewing the two satellites.

3.2 MCC Shuttle Data Flow. The following paragraphs describe the major data flows within the MCC in support of Shuttle operations. Primary data flows shall be:

- Telemetry
- Trajectory
- Command
- Video
- Teletype
- Voice.

3.2.1 Telemetry. Telemetry data shall be received by the MCC from three sources: GSFC, TDRSS, and the Shuttle Mission Simulator (SMS) in JSC Bldg. 5. Shuttle operational instrumentation (OI) telemetry data shall arrive at the MCC independently or simultaneously from one or any combination of these sources over a 1.544 Mb/s interface. Data shall be routed into the MCC via common carrier interfaces into the MCC modulator/demodulator (MODEM) and Line Driver/Termination Equipment. The data shall normally be routed through this facility into a GSFC network demultiplexer where it shall be demultiplexed and routed.

3.2.1 Telemetry. (Continued)

Data not addressed to JSC shall be routed from the demultiplexer unit into a GSFC multiplexer unit for output relay to other destinations, i.e., White Sands (WHS). All incoming JSC data shall be routed through the Digital Data Line Switch to the Network Communications Interface Common (NCIC) unit of the Network Interface Processor (NIP) in blocked data format (BDF). See figure 2.

The NCIC shall accept the wideband data (WBD) input and prepare the data for further processing by the Telemetry Processing Computer (TPC). The NCI shall perform the required communications management-type functions including synchronization, poly-code checking, header processing, error statusing, and selective message handling. In addition, the NCI shall perform air to ground (A/G) subframe synchronization, ground receipt time tagging, digital voice stripping (if required), and A/G error statusing. Data from the NCI/TPC Subsystems shall be output to the Shuttle Data Processing Complex (SDPC), Analog Event Subsystem (AES), and Dump Data Playback (DDP) Subsystem for processing.

Telemetry data shall be recorded in raw form by the WBD Recorder/Reproducer Subsystem. This data shall provide a history of all incoming data into the MCC.

The TPC's shall provide an output of analog and bilevel event data, stripped from the incoming data stream, to the AES for direct display on recorder and/or light displays.

Telemetry data received from the STDN consisting of dumped spacecraft recorder data shall require additional processing after passing through the NCI to establish a proper data relationship. Dump data may enter the system in either the forward or reverse mode with dead spaces intermixed in the stream. The DDP Subsystem shall be capable of processing multiple dump data streams and perform the following operations:

- Accept reverse/forward mode dump data from NCI
- Convert reversed/forward mode data to forward mode

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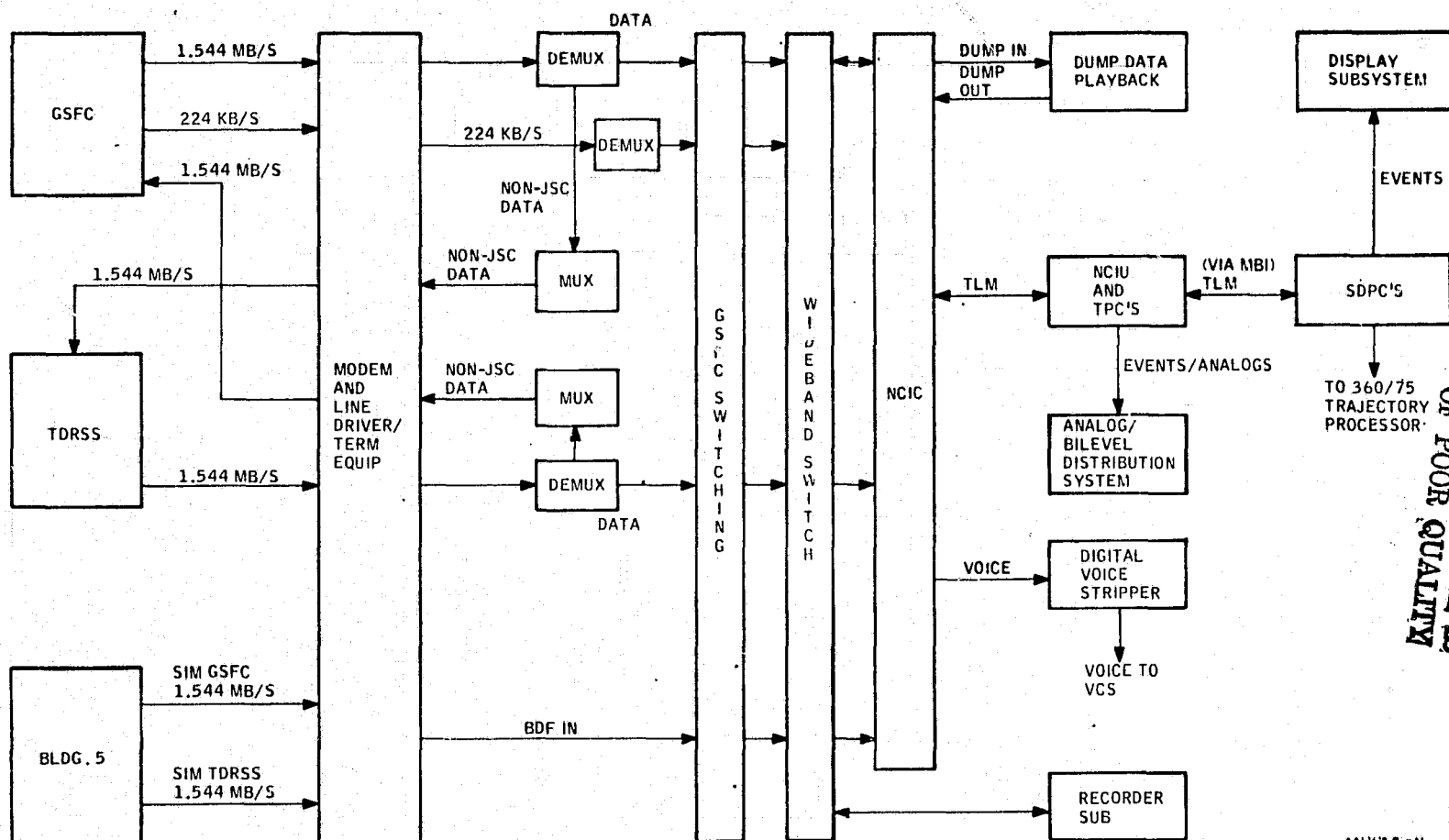


Figure 2 MCC Shuttle Telemetry Data Flow

3.2.1 Telemetry. (Continued)

- Chronologically order the data by spacecraft time
- Provide the NCI with forward, chronologically ordered, bit contiguous dump.

The SDPC shall accept multiple data stream inputs from the TPC's. Telemetry data shall be processed within the SDPC for output to users. Processing functions accomplished within the SDPC shall be:

- Calibration and limit sensing
- Command verification and history tabulation
- Downlink control
- Telemetry delogs
- Real-time computation and analysis
- Engineering unit (EU) conversion
- Data presentation
- Scaling
- Telemetry History Report in Formatted Tabulations (THRIFT) logging.

The SDPC shall provide telemetry data-derived products, (i.e., displays, log tapes, event lights, alarms, console readout devices) to MCC users. Both raw and processed data shall be used for presentation. Telemetry data shall also be provided to the 360/75 Trajectory Processor via the System Configuration Unit (SCU) and System Selector Unit/System Selector Extension Unit (SSU/SSEU) for use in trajectory and tracking computations.

3.2.2 Trajectory. Trajectory data shall be received by MCC from five sources: GSFC, TDRSS, the SMS in JSC Bldg. 5, Eastern Test Range (ETR), and KSC.

Shuttle tracking data shall arrive at MCC either independently or simultaneously from one or a combination of any of these sources. Tracking data from STDN shall be received over the 1.544 Mb/s input lines intermixed with telemetry data. The incoming data stream shall be handled in the same manner as specified in paragraph 3.2.1 except that the NCI shall route the tracking data directly to the SDPC via the Multibus Interface (MBI) instead of to the TPC. The SDPC shall optionally log the tracking data and output it to the 360/75 Trajectory Processor via the SCU and SSU/SSEU for processing, analysis, and display. See figure 3.

Launch and landing radar data from the ETR Real-Time Computer System (RTCS) shall arrive at the MCC via a 2.0 kb/s line. This data shall be routed through common carrier circuits into the Mission Operations Wing (MOW) MODEM and Line Driver/Termination Equipment, where it shall be throughput to an IBM Data Control Unit-Receiver (DCU-R) via the high-speed data patch bay. Simulated Impact Predictor (IP) data shall be routed from Bldg. 5 through a similar line arrangement to a DCU-R. Both real-time and simulated IP data may be routed directly from the DCU-R's to the 360/75 for processing.

Wind profile data from launch and landing sites routed to KSC shall arrive at the MCC via a 2.0 kb/s line. This data shall be routed through common carrier circuits into the MOW MODEM and Line Driver/Termination Equipment, where it shall be throughput to Bldg. 12 for use in Wind Tables. This data is also expected to be input into the MCC 360/75 computer, but the method is to be determined (TBD).

The 360/75 complex shall accomplish all trajectory processing functions for generation of output products to users. Outputs shall be in the form of displays, tabulations, and plots as required. Acquisition data to the STDN shall be generated in the 360/75 and throughput via the SDPC to the Network Output Multiplexer (NOM) for output. The data shall be information-tagged by the SDPC and blocked in NASA Communications Network (NASCOM) format by the NOM for transmittal over the 1.544 Mb/s line.

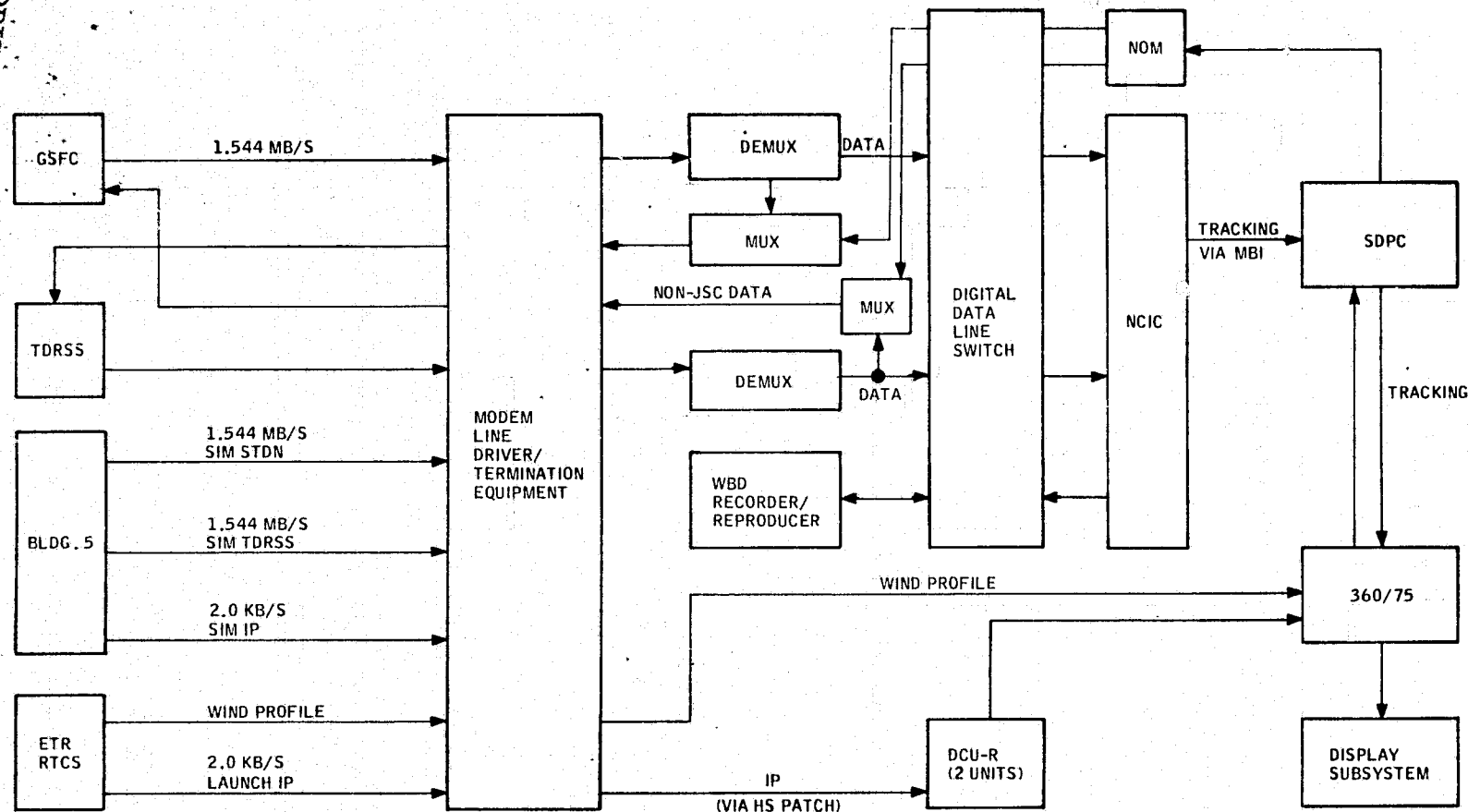


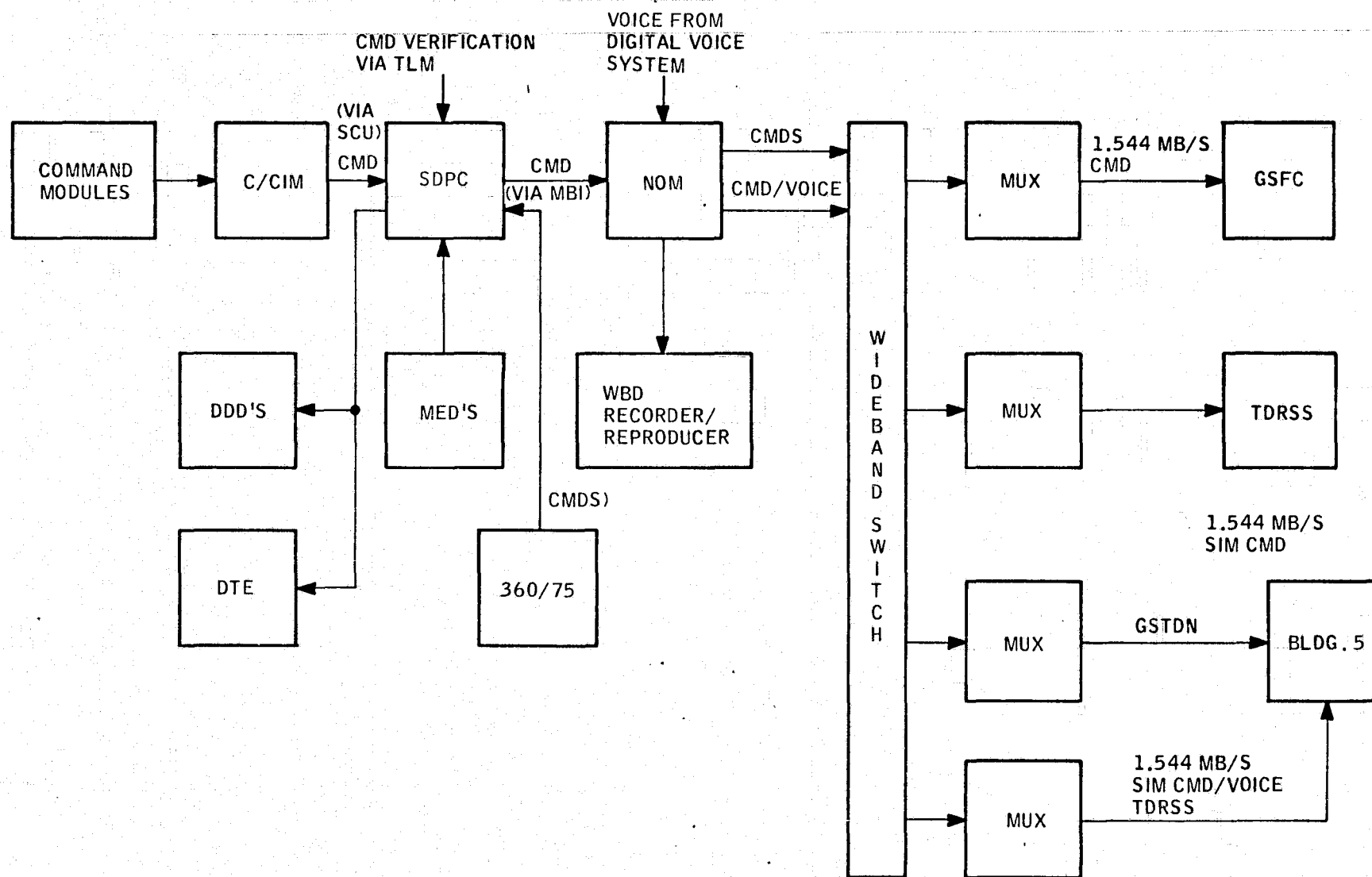
Figure 3 MCC Shuttle Trajectory Data Flow

3.2.3 Command. Command data from the MCC shall be initiated at the console command modules or manual entry devices (MED's). Command requests shall be passed from the command modules via the Command/Computer Input Multiplexer (C/CIM) and SCU to the SDPC, where the command requests shall be coded and commands generated. Trajectory data shall be generated by the 360/75 and passed to the SDPC for command generation. The SDPC shall generate and format command data for verification and throughput. MED inputs shall go directly to the SDPC through the SCU. Types of commands generated shall be (see figure 4):

- Real-Time Commands (RTC's)
- Loads
- Network Management Commands
- Stored Program Commands (SPC's)
- Text
- Display Electronics Unit (DEU) Commands
- Executes.

Command data shall be output from the SDPC via the MBI to the NOM. All data shall also be routed to the WBD recorder/reproducer for historical recording. The NOM unit shall output an interleaved voice/command data stream to the GSFC multiplexer units via the Digital Data Line Switch for output to TDRSS, and shall output commands only to GSTDN. Simulation command data shall be routed to Bldg. 5 from these same units to simulate either or both GSTDN and TDRSS uplinks.

Network management commands shall be transmitted to the remote sites from the MCC and shall be used to control and monitor remote site ground functions. These commands shall not be uplinked. This data shall be output from the SDPC via the MBI to the NOM where it shall be output without voice interleaving to GSTDN and/or TDRSS for site execution.



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Figure 4 MCC Shuttle Command Data Flow

3.2.3 Command. (Continued)

Command verification shall be received via telemetry and processed by the Telemetry System. These responses shall be passed to the command function and processed within the SDPC for command acknowledgement accounting. Verification of command load uplinks shall be processed as telemetry downlist and may be compared for validity before transmitting the command execute function.

3.2.4 Voice. The Voice Communications Subsystem (VCS) shall provide voice communications between MCC operating positions, and between operating positions and external locations. It shall also provide public address (PA) coverage for the MCC and A/G communications capability to and from the Space Shuttle vehicle. The VCS shall consist of the following elements:

- Console Communications Subsystem (CCSS)
- Communications Line Switch (CLS)
- PA Equipment
- A/G Equipment
- Digital Voice Subsystem (DVS)
- Central Power Equipment.

Incoming voice data shall be routed through the audio patch and CLS or via the DVS into the VCS for distribution to the voice recorders, PA system, or the operating position keysets. Outgoing voice shall use the reverse path for distribution to the various users.

3.2.5 Video. Video data shall be routed from internal/external sources to the MCC video patch equipment where it is patched to landline interface equipment within the DCS for display to users. Video generated within the MCC may be routed through the same network for internal or external use.

3.2.6 Teletype (TTY). TTY data to and from the MCC shall be routed through the Audio Patch facility to/from the Voice Frequency Telegraph (VFTG) equipment and the TTY patch facility to/from the message center. Transmission and reception of telegraph signals shall be provided by frequency division multiplexers of the VFTG. Monitoring and cross-patching capability shall be provided for all internal and external MCC TTY circuits. Private line teletypewriter service shall be provided between the MCC and all outside users (Meteorology, Defense Communications Agency, etc.) except NASCOM which interfaces via the VFTG equipment.

3.3 Mission Phase Support Elements. The MCC shall be required to provide support to Shuttle in a variety of configurations in normal and contingency operations. Mission phases identified for support are:

- Launch
- Landing
- Abort/Contingency
- Flight Simulations
- Nominal On-Orbit Operations.

Each support area imposes operational restrictions upon the MCC and the needed tools must be available to meet these conditions. The following assumptions are made concerning MCC support for these mission phases:

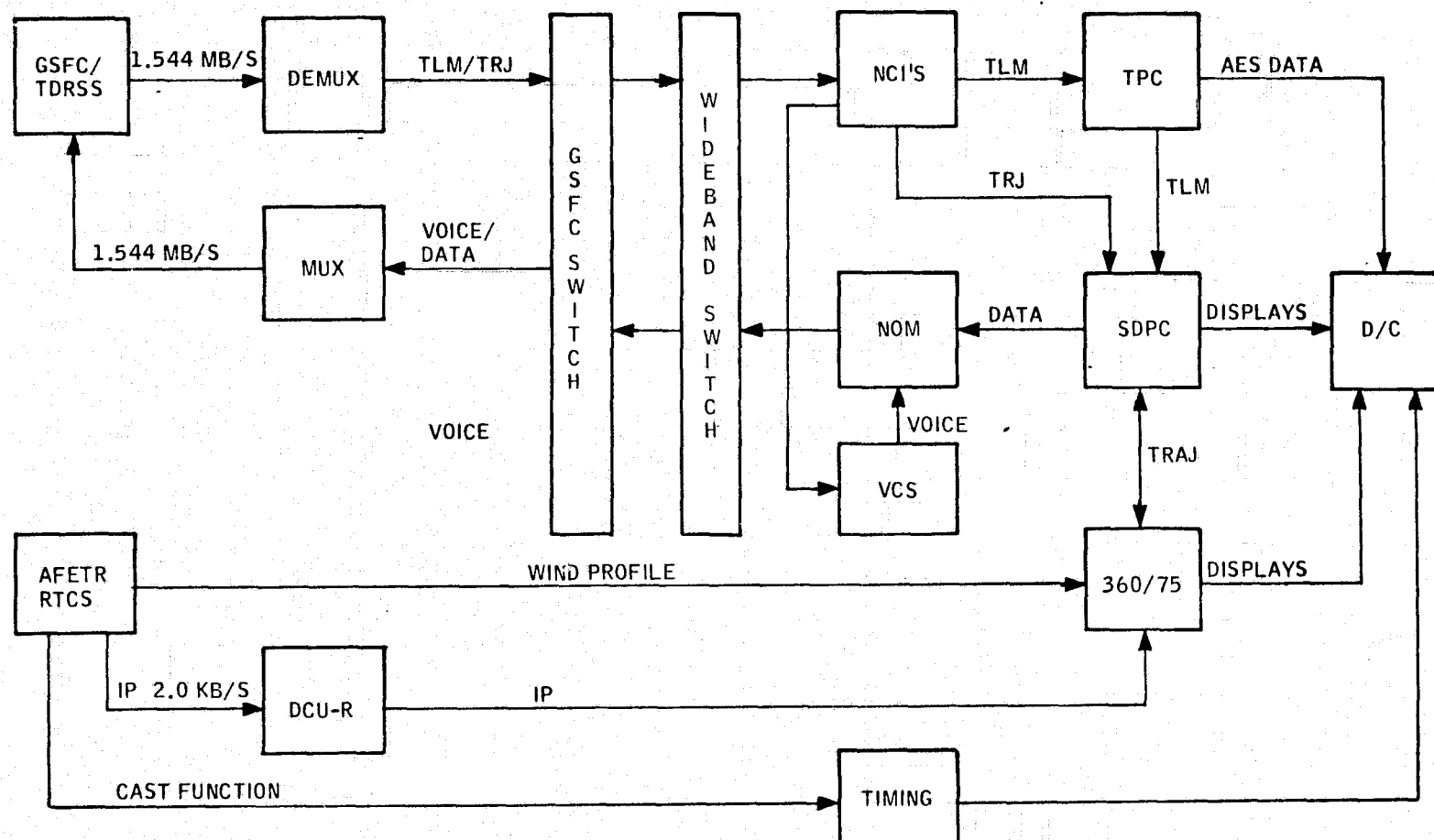
- a. All MCC resources shall be available for support as needed.
- b. No routine simulation shall be conducted during critical phases.
- c. Those resources not committed to mission support shall be available on a 30-minute callup basis.

3.3.1 Launch. The launch mission phase is considered critical and shall require dedicated online and dynamic standby resources in all areas where failures could disrupt or degrade mission support capabilities. Supporting resources such as the following must be available (see figure 5):

- Network Communications Interface (NCI) Processor
- Telemetry Processing Computers (TPC's)
- Shuttle Data Processing Computers (SDPC's)
- Trajectory Processors (360/75's)
- Network Output Multiplexers (NOM's)
- Multiplexer/Demultiplexer (MUX/DEMUX)
- Display/Control Elements [digital television equipment (DTE), command modules, etc.]
- WBD Switch
- Data Control Units (DCU-R) (i.e., IP data)
- A/G Voice Communication
- Countdown and Status Receiver System (CASRS).

These resources designated as data processing facilities shall be configured as dual systems with all data flowing in redundant paths so that selectover can be accomplished to an alternate in case of system failure or degradation. Operations shall be conducted in such a manner that the best available source of data will be processed for output. Data integrity must be maintained at all times.

3.3.2 Landing. The landing mission phase is considered critical and shall require dedicated online and dynamic standby



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Figure 5 MCC Data Flow

3.3.2 Landing. (Continued)

resources in areas where failure could disrupt or degrade mission support capabilities. All resources listed in paragraph 3.3.1 above, except countdown and status data and IP data shall be necessary for support during this mission phase. Heavy emphasis shall be placed on telemetry and trajectory processing capabilities due to the unusual nature of the Shuttle entry profile. Post-blackout support shall be highly critical in tracking and telemetry processing for analyzing the vehicle Terminal Area Energy Management (TAEM). Close ground support by MCC shall be required until handover to the landing site controller. Processing which does not have a direct relationship to this mission phase shall be minimal.

3.3.3 Abort/Contingency. Non-nominal operations such as aborts and on-orbit contingencies shall require fast, efficient reflex action by the MCC. Such activities shall require that any and all resources which lend themselves to problem solutions and predictions be available if required. JSC resources such as simulations, math models, and mock-ups which can be used to assist in decision making shall be on call. Such activities may require that all nonmission-related activities cease and the resources they use be committed to mission support. Nonmission resources such as LACIE, ALSEP, SDL, DRAFT, and other such activities are prime candidates in this area.

3.3.4 Flight Simulation. The capability to support realistic Shuttle OFT flight simulations shall be provided. Input simulated flight data shall originate in the SMS in Bldg. 5 and be transmitted to the MCC. All simulation data shall be in the same format as mission data received from or transmitted to the GSTDN or TDRSS. The SMS shall simulate not only booster/Orbiter/payload functions but also the GSTDN/TDRSS functions.

Types of simulations to be supported shall include launch, landing, and orbital. Simulations shall be required to present high fidelity telemetry, command, tracking, and voice data to the MCC. Simulation exercises shall cover both nominal and abnormal mission situations.

3.3.4 Flight Simulation. (Continued)

No simulation-unique hardware or software shall reside in the MCC; simulation control consoles and all special data faulting equipment shall exist external to the MCC (except simulation monitor consoles).

3.3.5 Nominal On-Orbit Operations. The capability to support nominal on-orbit operations shall be provided by the MCC. Those resources listed in paragraph 3.3.1 except for the DCU-R and CASRS shall be necessary for support during this mission phase. MCC support operations shall include computer complexes and operations support functions in the areas of trajectory and mission planning, command, telemetry, communications, and display required to accomplish command and control of the Orbiter vehicle and its attached payloads.

3.4 MCC Functional Allocations. The functional requirements, as defined in the *MCC Level A Requirements for Shuttle, Vol. 1: OFT*, shall be allocated to three MCC systems (see figure 6):

- Communications Interface System (CIS)
- Data Computation Complex (DCC)
- Display and Control System (DCS).

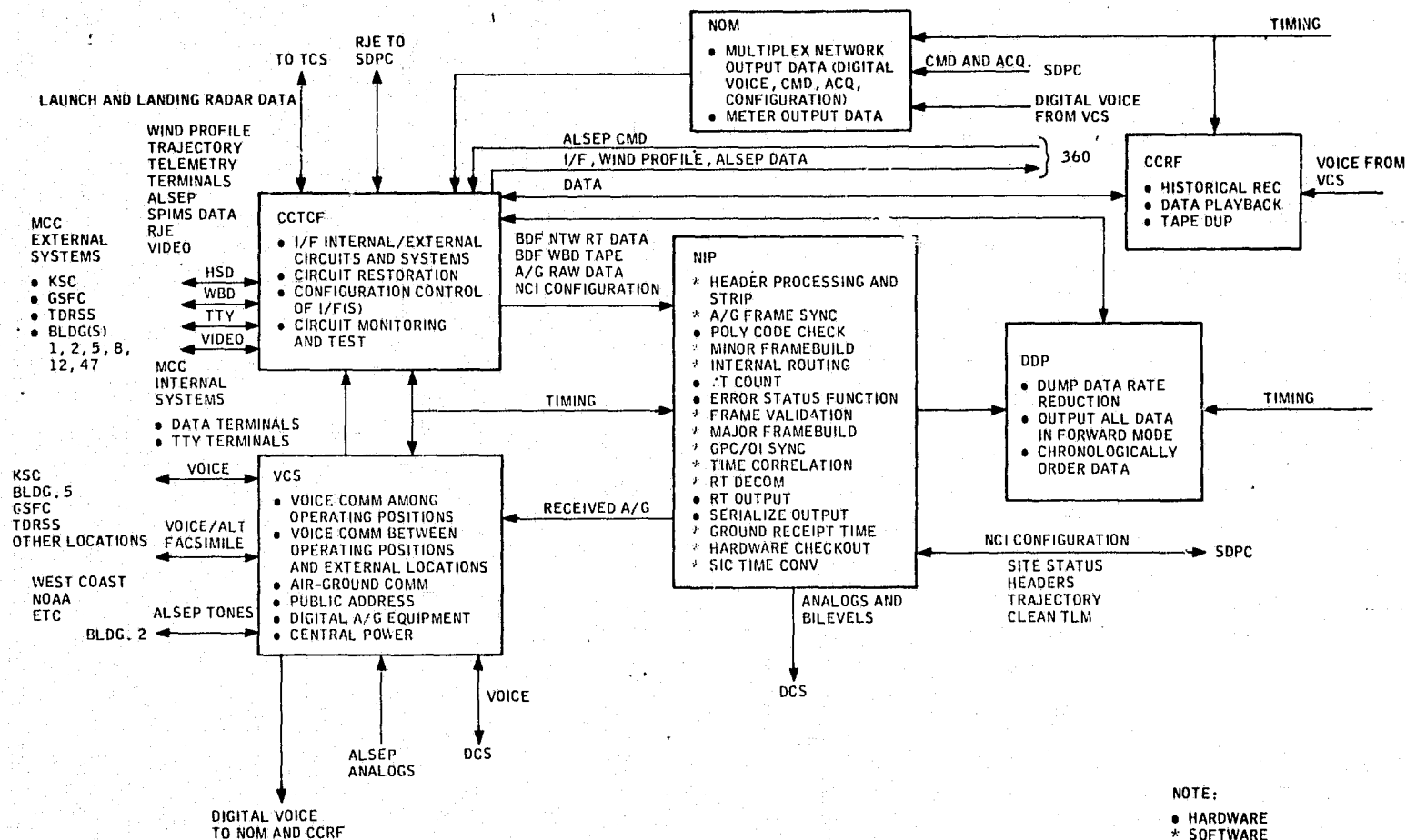
3.4.1 Communication Interface System. The CIS (as shown in figure 7) shall perform the functions of providing voice and data communications within the MCC, and between the MCC and external circuits. Functions allocated to CIS subsystems shall be as follows:

- a. Communication Circuit Technical Control Facility (CCTCF). The CCTCF shall provide terminations and configuration for all external voice, data, video, and TTY circuits entering and leaving the

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NOTE:
 • HARDWARE
 * SOFTWARE

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Figure 7 CIS Functional Allocations

3.4.1 Communication Interface System. (Continued)

MCC, and termination/configuration for all MCC systems requiring access to external circuits. It shall include capability to interface and reconfigure the circuits and provide measurement of circuit performance.

- b. Network Interface Processor (NIP). The NIP shall provide processing of incoming network data to the extent of determining data validity and quality; extracting voice data, tracking and site status, configuration data, and telemetry data; and preprocessing individual vehicle data for transmission to the SDPC.
- c. Network Output Multiplexer (NOM). The NOM shall provide interleaving of digital voice and SDPC output data for transmission to the network. Voice and data interleaving shall be accomplished when outputting to TDRSS; data shall be output only when transmitting to GSTDN. Interleaving shall not be performed for network management commands output to the network.
- d. Dump Data Processor (DDP). The DDP Subsystem shall provide a chronologically ordered output from a forward/reverse mode, high bit rate (HBR) spacecraft telemetry data dump.
- e. Voice Communication Subsystem (VCS). The VCS shall provide voice communications among MCC operating positions, and between these operating positions and other external ground support locations. It shall provide PA coverage in the MCC, and A/G communications with the Orbiter, both analog through GSTDN and digital through TDRSS.

3.4.1 Communication Interface System. (Continued)

- f. Consolidated Communications Recording Facility (CCRF).
The CCRF shall provide historical recording of all data and selected voice communications entering or leaving the MCC.

3.4.1.1 External Interfaces. MCC Shuttle operations shall require that digital data, video, and voice communications be exchanged with a number of locations external to the MCC. The external locations may be on the JSC premises or may be remotely located. The following locations and interfaces shall be required for the Shuttle OFT timeframe.

- a. Flight Operations Interfaces. These interfaces shall be to the launch areas, the landing areas, and the on-orbit tracking network data sources. All shall provide real-time support of specific mission activities.
- (1) Launch Area. Launches during the OFT timeframe shall be from KSC and shall require KSC interfaces as follows.
- (a) Voice. Approximately 40 full-duplex 3 kHz voice circuits shall be required for coordination purposes. These shall be direct JSC/KSC circuits including A/G.
- (b) Video. One receive-only 525 line scan rate (LSR) video circuit shall be required to permit JSC visual observation of launch operations. It shall be a direct KSC/JSC circuit.
- (c) Data. Three receive-only high-speed data circuits shall be required from KSC. One circuit shall provide meteorological data

3.4.1.1 External Interfaces. (Continued)

(wind profiles); another shall provide launch/landing radar data from the ETR RTCS via KSC; and the third shall provide countdown and status data. All circuits shall be direct KSC/JSC circuits.

- (2) Landing Areas. Landing during the OFT time-frame shall utilize KSC and Edwards AFB as primary sites, with Hickam AFB and Anderson AFB as secondary landing sites. (NOTE: For emergency operations, 50 contingency fields capable of handling the vehicle may be used. However, only analog voice support will be available from these other facilities.)
 - (a) Voice. Each of the landing areas shall require full-duplex 3 kHz voice circuits for landing coordination. These shall be direct circuits from each site to JSC including A/G.
 - (b) Video. One receive-only 525 LSR video circuit shall be required from each landing site to JSC for support of payload and landing site operations. The circuits shall be direct from each landing area to JSC, except that the launch video circuit from KSC may be used for landing and need not be duplicated.
 - (c) Data. Data required to and from the landing sites shall be of the same type required for on-orbit operations except for the addition of wind profile data from KSC, and shall be interfaced through the GSFC interface specified for on-orbit operations. Data volume may vary with support phase.
- (3) On-Orbit Network Support Areas. On-orbit data shall be exchanged with the Orbiter and ground

3.4.1.1 External Interfaces. (Continued)

support stations comprising STDN during early OFT, with the addition of TDRSS during later OFT.

- (a) Voice. Voice circuits shall be required to each GSTDN remote site for voice A/G traffic and for network coordination, and to WHS and/or GSFC for TDRSS ground station coordination. The voice lines shall consist of full duplex 3 kHz circuits to GSFC, where they shall be switched by GSFC as required to the remote site(s). Two lines shall be used for A/G traffic, one for coordination and one for dump voice playback. Additional voice coordination lines shall be used to coordinate TDRSS operations with WHS and/or GSFC.
- (b) Video. One receive video circuit shall be required from each GSTDN site and from the TDRSS ground station to provide for transmission of downlinked video data. Where a video circuit is provided for launch or landing support from a site, the same circuit can be used for orbital support and need not be duplicated. Video circuits shall be schedulable.
- (c) Data. The GSTDN data interface shall be via a full duplex 1.544 Mb/s to GSFC, with a 224 kb/s backup. TDRSS data interface shall be via a full duplex 1.544 Mb/s primary circuit to the TDRSS ground station at WHS. TDRSS backup shall be through the primary GSFC line to GSFC, then to the TDRSS ground station by a separate GSFC/ WHS 1.544 Mb/s line. Data from both network data sources shall consist of intermixed blocks of downlink (Orbiter) data

3.4.1.1 External Interfaces. (Continued)

and tracking/site status (site-originated) data. Data to the network shall consist of intermixed command uplink and acquisition/site configuration data.

- b. ALSEP. ALSEP shall be supported for an indefinite period into OFT and shall require two high-speed duplex lines to GSFC for transmission of ALSEP commands and receipt of experiments data. These circuits shall be entirely separate from Shuttle support circuits.
- c. Shuttle Avionics Integration Lab/Electronic Systems Test Lab (SAIL/ESTL). An SAIL/ESTL interface functionally resembling the GSFC data interface shall be required. Details are to be supplied (TBS).
- d. Video Processing and Release. TBD.

3.4.1.2 Communication Circuit Technical Control Facility (CCTCF). The CCTCF shall consist of the following hardware elements:

- MODEM's and Line Driver/Termination Equipment, providing data transmission over long-line circuits
- Data patching, switching, and test equipment, providing access to digital data circuits for testing, monitoring, and restoration
- IP DCU-R providing interface between the high-speed data MODEM and the 360 multiplexer line adapter unit
- GSFC MUX/DEMUX, providing interleaving and segregation of JSC traffic from non-JSC traffic on the network data
- TTY patch and test, providing access to TTY circuits for testing, monitoring, and restoration

3.4.1.2 Communication Circuit Technical Control Facility (CCTCF). (Continued)

- Terminal system patch and test equipment, providing access to data terminal circuits for testing, monitoring, and restoration
- Voice Frequency (VF) Patch and Test Facility providing access to NASCOM and internal voice communication circuit to permit cross-patching, equipment isolation, testing, and monitoring the circuits
- Interrange Instrumentation Group (IRIG) distribution equipment, providing for distribution of IRIG Format B modulated Greenwich Mean Time (GMT) signals to MCC users and various MCC external users.

3.4.1.3 Network Interface Processor (NIP): The NIP shall consist of the following elements:

- NCIC, providing for interface with network WBD links and performing communication management-type functions including BDF synchronization, poly-code checking, header processing, selective message handling, ground receipt time tag adjustment, and communication error statusing
- NCIU, providing A/G frame synchronization, frame validation, minor frame building, and frame time correlation
- Telemetry preprocessors, providing operational downlink and minor frame/data cycle validation, time correlation and reformatting, special processing and output formatting, output time tagging, output products reformatting, computer-compatible tape (CCT) output (postmission analysis), and data output to SDPC.

3.4.1.4 Network Output Multiplexer (NOM). The NOM units shall output an interleaved voice/command data stream to the GSFC multiplexer units via the Digital Data Line Switch for output to TDRSS, and commands only to GSTDN. Simulation command data shall be routed to Bldg. 5 from these units to simulate either or both GSFC and TDRSS uplinks. The NOM shall be capable of supporting multiple data streams and shall perform the following operations:

- Accept command data and acquisition from the SDPC(s)
- Verify station ID
- Verify parity
- Interleave digital voice and command where applicable
- Perform uplink formatting for TDRSS interface
- Perform NASCOM blocking
- Provide proper time tags and sequence numbers
- Serialize data to MUX
- Provide error protection
- Generate fill data where required.

3.4.1.5 Dump Data Processor (DDP). Telemetry data received from the STDN which consists of dumped spacecraft recorder data shall require additional processing after passing through the NCI in order that a proper data relationship be established. Dump data may enter the system in either forward or reverse mode with dead spaces intermixed in the stream. DDP shall be capable of processing multiple dump data streams and shall perform the following options:

- Accept reverse/forward mode dump data from the NCI
- Convert reversed/forward mode data to forward mode

3.4.1.5 Dump Data Processor (DDP). (Continued)

- Chronologically order the data by spacecraft time
- Provide to the NCI the forward, chronologically ordered, bit contiguous dump data.

3.4.1.6 Voice Communication System (VCS). The VCS shall consist of the following elements:

- CLS, consisting of a manually-controlled switchboard to configure external lines and/or loops together
- Console communication equipment, consisting of keysets and loop (conference circuit) equipment to permit operating personnel to communicate among themselves and between outside locations
- Voice analog A/G equipment, providing the capability to generate tones to key remote transmitters and to select NASCOM long lines for connecting between A/G circuits and selected MCC operating positions
- Digital A/G voice equipment to interface the analog A/G equipment with the Orbiter uplink/downlink digital streams
- PA equipment, providing for paging, announcing, etc.
- Central power equipment, providing uninterruptable power for operation of all voice communication equipment.

3.4.1.7 Consolidated Communications Recording Facility (CCRF). The CCRF, consisting of data and voice recorders, shall provide historical recording of all data and selected voice communications entering or leaving the MCC. The facility shall also provide tape playback of recorded tapes and tape duplication. The system shall be capable of quick retrieval of recorded data.

3.4.2 Data Computation Complex (DCC). The DCC (as shown in figure 8) shall provide computational, peripheral, and switching capability which will support the requirements derived from the *MCC Level A Requirements for the Shuttle, Vol 1: OFT*. Non-Shuttle applications (e.g., SDL, LACIE, ALSEP) shall also be supported by the DCC.

The DCC, a distributed processing complex, shall consist of the following four elements:

- a. Multibus Interface (MBI). The MBI shall provide a common data bus enabling multiple paths that can be established dynamically on a demand basis between the SDPC, TPC, NCIC, NOM, and analog event drivers (AED's).
- b. Shuttle Data Processing Complex (SDPC). The SDPC shall provide the processing of communication, command, and telemetry functions.
- c. 360/75 Computer Complex. The 360/75 Computer Complex shall provide primarily for the processing of trajectory data and for nonreal-time OFT mission support.
- d. Terminal Control Subsystem (TCS). The TCS shall provide terminals both within and external to the MCC from which program and mission data may be requested and displayed. The subsystem shall utilize one 494 computer with backup (existing TCS) to provide an interim capability until the function is activated in the SDPC. This system shall access the CYBER computer in the Support Operations Wing (SOW) and the UNIVAC 1108/1110 System in Bldg. 12. These systems shall contain Shuttle Program Information Management System (SPIMS). These computers shall also contain Central Computing Facility (CCF) data for Bldg. 12 Institutional Data Systems Division (IDSD) use.

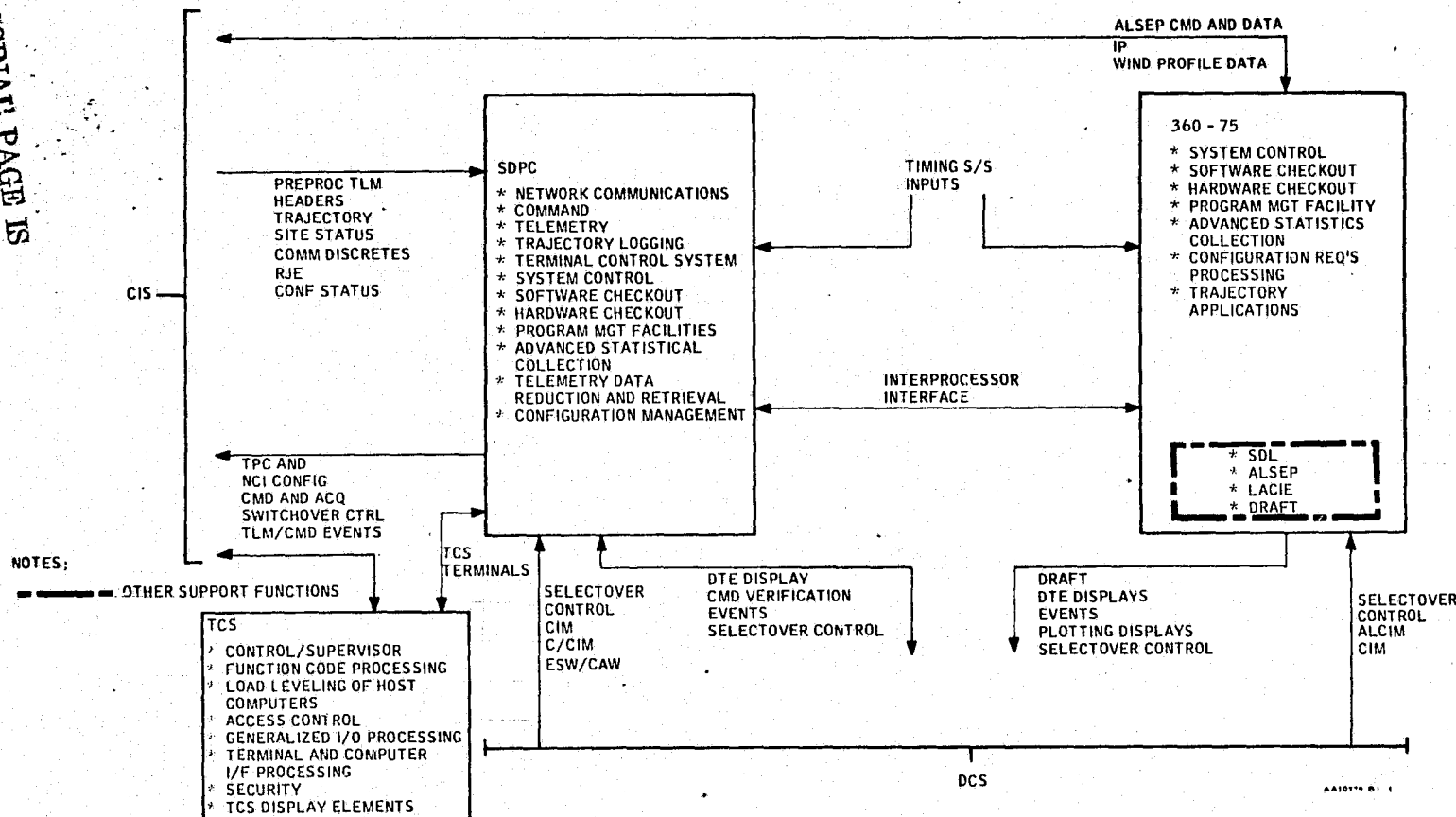


Figure 8 DCC Functional Allocations

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3.4.2.2 Shuttle Data Processing Complex (SDPC). (Continued)

- c. Telemetry. This function shall validate, calibrate, and perform special computations on telemetry data, and perform real-time display, data retention, and data tracking and management functions.
- d. Telemetry Data Reduction. This function shall obtain and reduce MCC recorded historical telemetry data for inflight presentation of the Orbiter operational downlink.
- e. TCS. This function shall provide the man/machine interface for interactive users of data information, and provide data paths between the user and application functions.
- f. Command and Control System (CCS) Control. This function shall perform mission initialization and control, logging, delogging, time and data routing, input decoding, display formatting and management, digital display driver (DDD) management, and simulated input processing.
- g. Software Checkout System. This system shall provide the capabilities needed for software testing by performing test control, data generation, presentation and delivery, data scoring and comparison, automatic data response simulation, user output, and post-test analysis functions.
- h. Hardware Checkout System. This system shall provide the capabilities for performing hardware certification and verification testing and assist in hardware fault isolation and identification; includes functions for testing MCC hardware systems, subsystems, consoles, display devices, external interfaces, and special purpose hardware and/or interfaces.

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3.4.2.2 Shuttle Data Processing Complex (SDPC). (Continued)

- i. Program Management Facility. This facility shall maintain program libraries, with extensive accounting, reporting and cross-referencing capabilities, and provide support for programming languages.
- j. Advance Statistics Collector. This function shall collect detailed data relating to the utilization of CPU, I/O, and memory, and provide extensive data reduction capabilities.

3.4.2.2.1 Hardware Elements. SDPC hardware elements shall be as follows:

- a. Computer Complex
 - CPU
 - Tape drives
 - Card reader
 - Communication terminal interface units
 - Remote job entry (RJE)
 - External interface units
 - SDP/360 interface units
 - SDP/Channel-to-Channel Adapter (CCA) interface units
- b. Peripheral control unit providing for peripheral configuration control
- c. Random access storage
- d. Printer Pool

3.4.2.2.1 Hardware Elements. (Continued)

- e. Interactive terminal
- f. SDPC control area, providing for operational control of the SDPC.

3.4.2.2.2 Software Elements. SDPC software elements shall be as follows:

- a. Operating System. An operating system shall provide the basic capabilities needed to support the existing MCC hardware and application software in the following areas:
 - Real time data driven functions
 - Response critical interactive functions
 - Local and remote batch processing.
- b. Applications Software. Special applications software shall be provided as required to support telemetry, display, command, and message handling within the SDPC.

3.4.2.3 360/75 Computation Complex. The 360/75 shall perform the following functions in support of Shuttle data processing:

- a. CCS Control. This function shall perform mission initialization and control, logging/deloggging, simulated input processing, input decoding, and DDD management.
- b. Software Checkout System. This system shall provide the capabilities needed for software testing by performing test control, data generation, presentation, and delivery, data scoring and comparison, automatic data response simulation, user output, and post-test analysis function.

3.4.2.3 360/75 Computation Complex. (Continued)

- c. Hardware Checkout System. This system shall provide the capabilities for performing hardware certification and verification testing and assists in hardware fault isolation and identification; includes functions for testing MCC hardware systems, subsystems, consoles, display devices, external interfaces, and special purpose hardware and/or interfaces.
- d. Program Management Facility. This facility shall maintain program libraries, with extensive accounting, reporting and cross-referencing capabilities, and shall provide support for programming languages.
- e. Advanced Statistics Collector. This function shall collect detailed data relating to the utilization of CPU, I/O, and memory, and provide extensive data reduction capabilities.
- f. Trajectory. This function shall determine, predict, and plan the Orbiter trajectory, allowing the user to monitor and evaluate the trajectory and analyze alternatives during launch, abort, orbit, and entry phases.
- g. Configuration Requirements Processor (CRP). This function shall maintain files in which configuration requirements for MCC disciplines are collected, validated and retained and produce tables for use by MCC applications based on these requirements.

3.4.2.3.1 Hardware Elements. 360/75 computation complex hardware elements shall be as follows:

- 360/75 computers
- Dedicated peripherals
- CCA

3.4.2.3.1 Hardware Elements. (Continued)

- Selector channel string switch
- SSU/SSEU
- ICU
- 2701 data adapter, providing 360 channel control for communication with local and remote devices
- Line printer pool
- IMS terminals
- Special Purpose Array Processor, providing for LACIE data classification
- 2902 MLA, providing for multiplexing communication lines
- 360/75 control area, providing for operational control of the 360/75 complex
- Interactive terminal pool.

3.4.2.3.2 Software Elements. 360/75 software elements shall be as follows:

- a. Operating System. The 360/75 shall utilize an operating system which provides the basic capabilities needed to support existing hardware and applications software in the following areas:
 - Real-time data driven functions
 - Interactive functions
 - Local and remote batch processing.

3.4.2.3.2 Software Elements. (Continued)

- b. Application Software. Special applications programs shall be provided to support real-time trajectory computation activities and other nonreal-time support functions as described earlier in this section.

3.4.2.4 Terminal Control Subsystem (TCS). The TCS shall be used to support pre-OFT support functions. The interim TCS shall be replaced by the SDPC TCS/Terminal Support System following OFT, at which time the 494's shall be removed from the MOW. The system shall be used to access the SPIMS resident in the CYBER computer (Bldg. 30 SOW) and the 1108/1110 computers resident in Bldg. 12.

3.4.2.4.1 Hardware Elements. TCS hardware elements shall be as follows:

- 494 computers
- Computer Terminal Multiplexer Control (CTMC) Units
- A 4-way switch, providing for any of two 494's to be switched to the CTMC
- 494/360 adapter
- Standard Computer Communication Subsystem.

3.4.2.4.2 Software Elements. TSC software elements shall be as follows:

- Operating system and system support software
- TCS applications.

3.4.2.5 DCC-to-MCC Systems Configuration and Switching Equipment. In addition to the MBI discussed in paragraph 3.4.2.1, the MCC shall contain equipment which shall be used to interface and configure the DCC computer systems with communications, display, and the control systems. This equipment shall consist of:

- SCU
- SSU/SSEU
- 360/75 string switch.

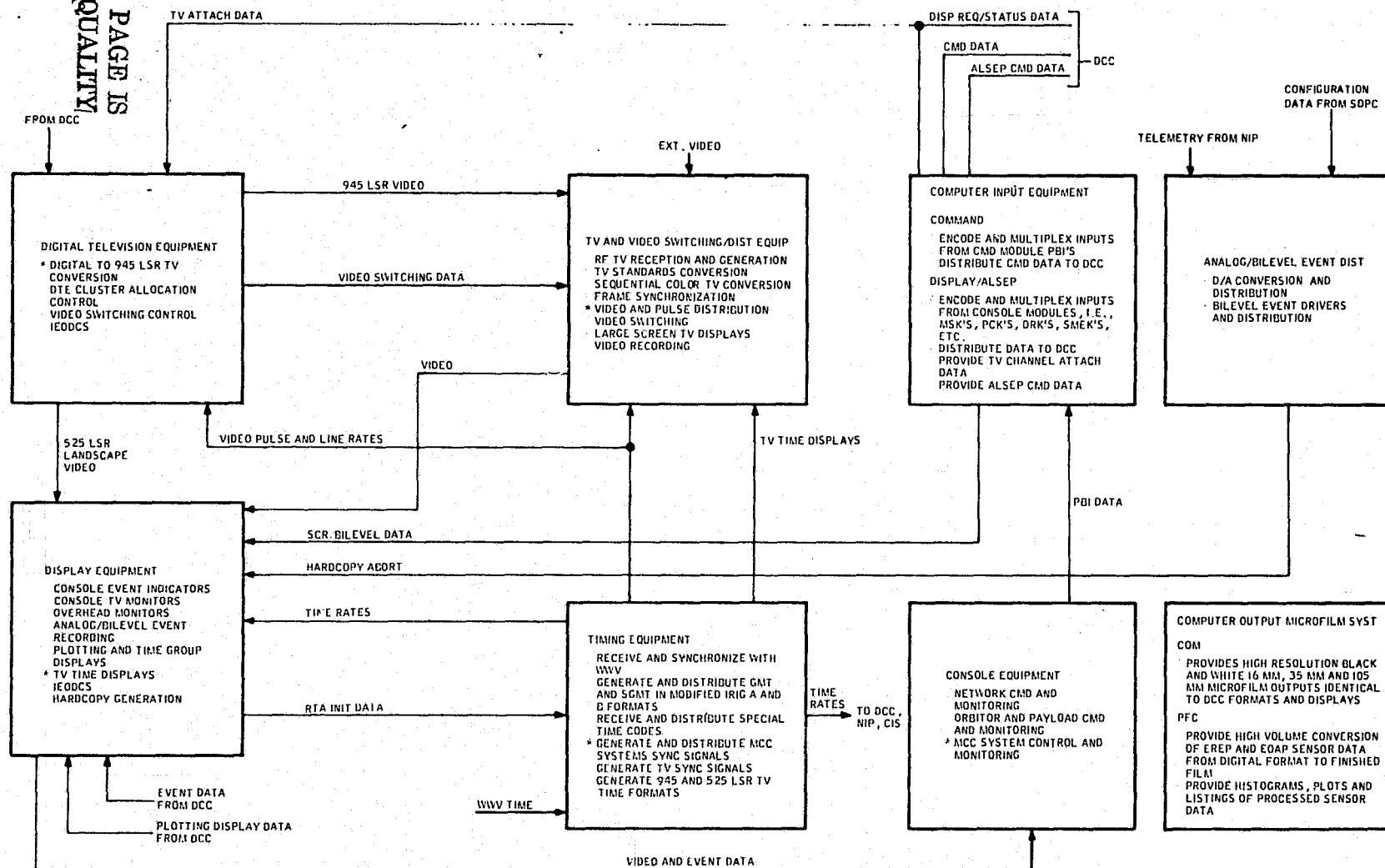
This equipment shall provide switching and routing capability for circuits requiring SDPC and/or 360/75 and/or U-494 processing. The capability to exercise either semiautomatic or manual configuration changes shall exist.

3.4.3 Display and Control System (DCS). The DCS (as shown in figure 9) shall perform in conjunction with the DCC and CIS to provide OBT mission and support personnel the capability of requesting and monitoring computer data in several media. In this capacity the system shall detect, encode, and transmit operator requests in the form of either display requests, configuration control messages, command requests, or data management information to the DCC. The DCC, in response to functional requests, shall provide the requested information in the proper media format to the DCS for utilization by such devices as strip-chart recorders, TV monitors, group displays, and event monitors, or send the information to its proper destination, network, or other JSC facilities. Other related DCS capabilities shall consist of providing the MCC with timing standards, hardcopy information in several media, switching and routing of display information, and conversion and taping of video information.

The DCS shall be comprised of the following subsystems:

- Digital Television (D/TV)
- Television and Video Switching Distribution

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Figure 9 DCS Functional Allocations

3.4.3 Display and Control System (DCS). (Continued)

- Video Hardcopy
- Group Display
- Discrete Display Subsystem (DDS)
- Analog/Bilevel Event Distribution
- Console
- Timing
- Display Select Computer Input Multiplexer
- Command
- Computer Output Microfilm (COM)
- Pneumatic Tube.

Subsystem functional allocations are defined in the following paragraphs.

3.4.3.1 Digital Television (D/TV) Subsystem. This subsystem shall provide the capability to convert DCC language data into dynamic raster-type video displays containing both alphanumeric and graphic information.

3.4.3.2 Television and Video Switching Distribution Subsystem. This subsystem shall provide the capability to receive and display commercial TV broadcasts; switch and route all video within the MCC; record, edit, or playback video signals; perform scan rate conversion (945-to-525 or 525-to-945); provide synchronization of Electronic Industries Association (EIA) or National Television Standards Committee (NTSC) 525 LSR nonreference sync video signal with MCC references; provide conversion of orbiter sequential color video to an NTSC format; and provide TV camera coverage in MCC.

3.4.3.3 Video Hardcopy Subsystem. This subsystem shall provide the capability to make permanent hardcopy and film record of video displays at operator request.

3.4.3.4 Group Display Subsystem. This subsystem shall provide the capability for group viewing on large-screen displays of video information in the Mission Operations Control Room (MOCR) and Bldg. 30 auditorium.

3.4.3.5 Discrete Display Subsystem. This subsystem shall provide the capability to accept DCC event data and display that information at consoles in the form of lamp indications.

3.4.3.6 Analog/Bilevel Event Distribution Subsystem. This subsystem shall accept analog and event data from up to six TPC's and distribute to analog and event recording devices.

3.4.3.7 Console Subsystem. This subsystem shall provide the display and control end devices required for operator man/machine interface with the systems. The console function shall provide the link between the operator and computer input and output, transforming human action into basic encoded messages, and computer output words into visual and/or audible indications.

3.4.3.8 Timing Subsystem. This subsystem shall function as the timing standard for the MCC Shuttle data systems. It shall be capable of generating and distributing GMT in various formats and timing pulses at numerous pulse rates, for time correlation by MCC systems. In addition to generating time signals, the subsystem shall accept either live or simulated launch countdown data for distribution to various display devices. It shall provide ground elapsed time, stop clock, and coincidence signals throughout the MCC.

3.4.3.9 Display Select Computer Input Multiplexer Subsystem. This subsystem shall provide the capability to detect console entry display requests or other functions assigned to the console panel, and format and route this information to the DCC.

3.4.3.10 Command Subsystem. This subsystem shall have the capability to format entries from the Console Subsystem and transfer that information to the DCC.

3.4.3.11 Computer Output Microfilm Subsystem. This subsystem shall provide the capability of offline generation of alphanumeric and graphic mission-related information from computer-generated digital tapes. The subsystem shall be capable of rapid processing, duplication, and display of high resolution film images (16 mm, 35 mm, and 105 mm).

3.4.3.12 Pneumatic Tube Subsystem. TBS.

3.5 System Configuration Management. The MCC system configuration management function shall provide the capability to manage, control, and document the configuration of the major systems described in this document. This function shall allow efficient and responsive management and control of the resources in meeting requirements to concurrently support Shuttle program development, testing, simulation, and flight testing. The configuration resources shall be the systems data, the systems hardware, the hardware/software interface elements between the systems, and the interface elements required for interfacing with external systems to the MCC.

The systems configuration management shall provide a vehicle for collection, integration, and implementation of user requirements to support all ongoing MCC activities. It shall establish communications paths for receiving, transmitting, processing, recording, and routing data within the MCC configuration. It shall provide the capability to reconfigure the MCC resources on a

3.5 System Configuration Management. (Continued)

flight-to-flight or inflight basis. It shall also provide operations, maintenance, and scheduling personnel the capability to operationally reconfigure the data path routing, allocate resources, monitor the status and health of the various elements of the configuration, initialize systems, failover systems, restart systems, and display the status of the configuration.

The three primary configuration management activities shall be as follows:

- Configuration Integration
- Reconfiguration Control
- Operational Configuration Management.

A general description of each of these activities is made in the following paragraphs. Details are TBS.

3.5.1 Configuration Integration. Configuration integration shall include those disciplines and activities required to identify, control, analyze, implement, document and test additions, deletions, and changes to the configuration resource baseline. This type of change shall require engineering and/or programming support to implement. Changes shall include addition or deletion of consoles, modules, keysets, programming logic, processing and interface conventions, and historical voice recorder channel assignments.

3.5.2 Reconfiguration Control. Reconfiguration control shall include those disciplines and activities required to control, analyze, and implement configuration changes to satisfy user requirements. This type of change shall not require engineering changes to the equipment or programming changes to the software. It shall include changes such as reassignment of voice loops to pushbutton indicators (PBI's), reformatting of software tables, addition or deletion of measurements, modification of

3.5.2 Reconfiguration Control. (Continued)

calibration or limit sense constants, modification of display content, reformatting of analog or event tables, modification of TV display content, and rearrangement or modification of assignments. Changes of this type are normal on a flight-to-flight basis. Changes shall be completed via data pack, data integration, display format, and preprocessing tasks.

3.5.3 Operational Configuration Management. Operational configuration management shall include those disciplines and activities required to support operations and maintenance personnel in configuration of the resources to satisfy user operational requirements. This type of configuration/reconfiguration change shall utilize the builtin capabilities within each system. This shall include assignment of data paths, resource allocation, resource priority allocation, initialization, failover, and restart. Changes of this type shall be accomplished on a real-time as required basis. Capabilities will be provided to monitor and display configuration status and track the health of the systems to support this effort. The SDPC shall be utilized to initiate, monitor and/or control this type of change.

3.6 MCC Test and Checkout. MCC test and checkout shall be performed by use of hardware and software tools provided for that purpose. MCC readiness testing shall be performed prior to each Shuttle flight/mission and shall consist of procedural execution of selected hardware/software tests which are appropriate for that flight/mission.

3.6.1 Hardware Testing and Checkout. Hardware testing/checkout shall be performed by use of several different types of test tools, for example:

- Standard general purpose hardware test equipment
- Special purpose hardware test equipment including builtin test equipment (BITE)
- Software designed to support hardware test and checkout.

3.6.1 Hardware Testing and Checkout. (Continued)

In all of the above cases, external test data shall be input to the device under test and performance evaluated by visual or automatic scoring of outputs.

3.6.2 Software Testing and Checkout. Testing/checkout of Shuttle online support software shall be accomplished using scripted input test data and auto-scoring of computer outputs. For the major systems, NIP, SDPC, and 360/75, software test tools shall be provided as follows:

- a. NIP/TPC. Input test data shall be provided via WBD tape generated on U418 Generalized Confidence Tape System (GCTS) and offline auto-scoring by GCTS software.
- b. SDP. Input test data shall be provided by online SDPC data generator; script generator for the SDPC data generator shall be a 360/75 function. Scoring shall be performed by SDPC scoring software; auto scoring shall be performed online where cost effective. Some offline and manual scoring shall be required.
- c. 360/75. Input test data shall be provided by 360/75 online data generator; online auto-scoring shall be performed where cost effective. Some offline and manual scoring shall be required.

3.6.3 MCC and Network Validation Tests. Validation tests shall be supported by procedural execution of subsets of test and checkout software. Two primary validation tests are defined as the MCC end-to-end validation test and the network validation test.

3.6.3.1 MCC End-to-End Validation Test. Input test data shall be provided to the Orbital Flight Test Data System (OFTDS)

3.6.3.1 MCC End-to-End Validation Test. (Continued)

front end in 1.544 MB format. The test data source shall be WBD confidence tapes generated by the U418 GCTS; test results shall be obtained by auto-scoring computer system outputs. Functions tested shall be processing of telemetry, tracking, command, and voice and shall include retesting for proper hardware/software configuration on a sample test basis.

3.6.3.2 Network Validation Test. Input test telemetry data for STDN-to-MCC validation test shall be a WBD confidence tape generated on the U418 GCTS; playback shall be via STDN site WBD recorder. For TDRSS-to-MCC, the same procedure shall be used if a WBD recorder playback function is available; if not available, validation test procedure is TBD. Scoring shall be performed by logging TPC outputs and offline auto-scoring on U418 GCTS. Tracking, command, and voice validation testing procedures from STDN/TDRSS-to-MCC are TBD.

3.7 Other MCC Support Functions. The MCC shall provide the capability to support other activities not considered Shuttle mission activities. Programs in support of earth resources, medical record files, Apollo Lunar Surface Experiments Package (ALSEP), and software development are concurrent operations which shall be supported by the MCC. Operations in this category are:

- PPS
- MEDICS
- ALSEP
- LACIE/Interactive Earth Observation Display/Control System (IEODCS)
- SDL
- DRAFT

3.7 Other MCC Support Functions. (Continued)

- Natural Environment Support
- Special Purpose Processor (SPP).

3.7.1 Production Processor System (PPS) Support. The PPS shall be used to process earth resources data originating from satellites and specially instrumented aircraft. The primary type of data to be processed shall be imagery data from experimental electronic sensors. Output from the PPS shall be either raw or processed data on computer-compatible tapes (CCT's).

3.7.1.1 Hardware Elements. PPS shall consist of two PDP-11/45 minicomputer systems, each with following peripherals:

- Four dual density tape drivers
- Twin disk drivers
- Line printer
- Card reader
- Alphanumeric (A/N) CRT terminal
- LA35 DECwriter
- SPS-41 Array Processor
- 14-Track Interface (I/F) System
- SABRE-IV Instrumentation Recorder (14-Track)
- Color Display System
- Data Reformatter Assembler (DRA).

3.7.1.2 Software Elements. Software for the PPS shall consist of the Digital Equipment Corporation (DEC) Disk Operating System (DOS) (with modifications) and special applications programs.

3.7.2 Medical Information Computer System (MEDICS) Support. MEDICS shall be an online data base system with capability to retrieve/update/enter information via remote terminal. Primary use of the system shall be for storage/retrieval of astronaut/crew medical records; secondary use shall be for food information data base.

3.7.2.1 Hardware Elements. Hardware shall consist of the V74 minicomputer, with peripherals which shall include the following:

- Three disk storage units (one with 39M bytes and two with 58M bytes each)
- Four magnetic tape drivers (two 7-track and two 9-track)
- Line printer
- Card reader
- A/N CRT terminal
- TTY
- Expanded memory (96K words).

3.7.2.2 Software Elements. Software shall include VORTEX, a real-time operating system provided by Varian Data Machines. Applications software shall consist primarily of a data base system; one primary characteristic of the MEDICS data base shall be built-in security to prevent unauthorized access to medical record information.

3.7.3 Apollo Lunar Surface Experiment Package (ALSEP) Support. The MCC shall be required to perform certain functions fundamental to the support of the experiments packages in both a real-time command control system environment and in a stand-alone system. The following functions shall be provided in hardware and software which reside within a 360/75 computer with its interfaces to the ALSEP DCS.

- a. Telemetry-Related Processing Functions. The ALSEP System shall perform the following telemetry-related processing functions:
 - Accept ALSEP experiments and central station data from remote sites via NASCOM
 - Generate standard NASCOM acknowledgement messages for all data received from the STDN
 - Process received data for subsequent display and control
 - Perform EU conversion and limit checking
 - Format data for output to display and recording devices
 - Execute command validation and verification and route to appropriate destination
 - Perform special computations
 - Perform selective I/O logging activity.
- b. Command-Related Processing Functions. The ALSEP System shall perform the following command functions:
 - Process command validation, verification, Command Acceptance Pattern (CAP) messages, and site status CAP messages from the sites and provide status data to control personnel
 - Accept command request and generate the appropriate Command Execute Request (CER) message

3.7.3 Apollo Lunar Surface Experiment Package (ALSEP)
Support. (Continued)

- Format command data into standard NASCOM data blocks and route data for transmission to the GSFC
- Provide command history displays and printouts.

3.7.3.1 ALSEP Hardware Elements. ALSEP hardware shall be provided in two distinct groups; DCC equipment and ALSEP D/C equipment.

a. DCC

- 360/75
- ICU
- 2701
- ALSEP displays.

b. D/C

- ALSEP consoles
- ALSEP Computer Input Multiplexer (ALCIM)
- Digital Display Driver (DDD)
- DDD Interface Unit (DDDIU)
- Digital-to-Analog Converter Unit (DACU)
- DAC Interface Unit (DACIU)
- Seismic drum recorders

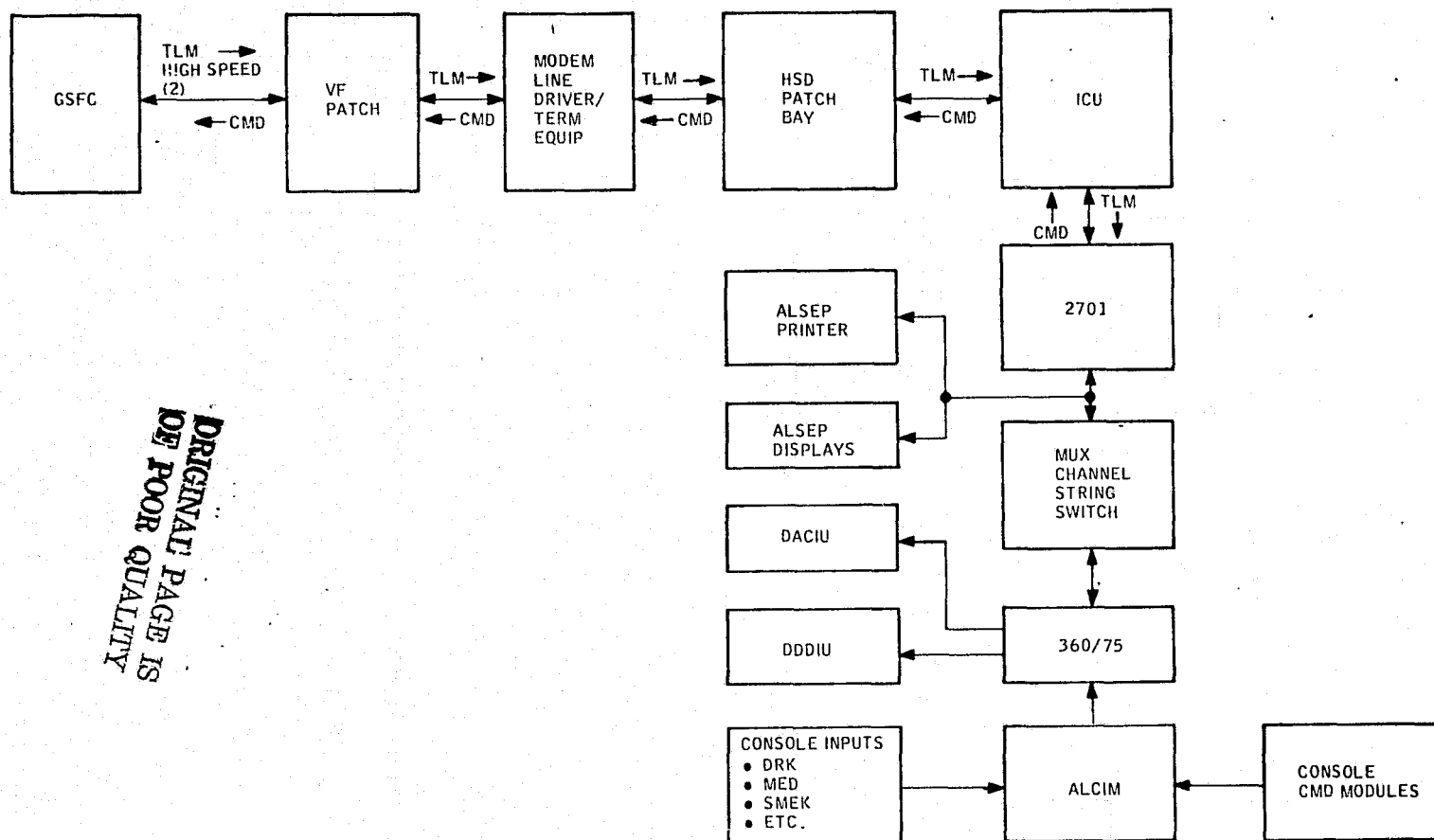
3.7.3.1 ALSEP Hardware Elements. (Continued)

- Chart recorders
- Stripchart recorders
- Analog meters
- DAC patch
- ALSEP Voltage Controlled Oscillators (VCO's)
- FM patchboard
- ALSEP printers.

3.7.3.2 ALSEP Software. The ALSEP software shall consist of ALSEP programs that run in the 360/75 computer under the Enhanced Operating System (EOS) and ALSEP applications software (refer to paragraph 6.2.5 of IBM's *OFT System Specification, Vol. 1, Section 6*).

3.7.3.3 ALSEP Data Flow. The MCC shall receive ALSEP telemetry data from GSFC via HSD lines with backup. Data flows into the MCC through the Voice Frequency (VF) Data Patch Facility and the MODEM and Line Driver/Termination Equipment to the HSD patch bay. The data shall be routed from this facility into the DCC where it shall be input to the 360/75 ICU. Telemetry data shall then be routed to the 2701; the 2701 output shall be input to the Multiplexer Channel String Switch (2914 No. 1), whose output shall be routed to the 360/75 computer (see figure 10). Processed data from the 360/75 computer shall be routed via the SSU/SSEU to the ALSEP DCS DDDIU and DACIU for display. Other outputs shall be routed via the Multiplexer Channel String Switch to ALSEP displays and the ALSEP printer unit.

ALSEP command data for output to the GSFC shall be initiated by console devices and input to the ALCIM unit for throughput to the



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Figure 10 ALSEP Telemetry/Command Data Flow

3.7.3.3 ALSEP Data Flow. (Continued)

360/75 Computer System. Commands shall be formatted, validated, and blocked for transmission by the system. Output command data shall flow from the computer to the Multiplexer Channel String Switch and be throughput to the ICU via the 2701. The data shall then be routed via the HSD patch, MODEM and Line Driver/Termination Equipment and the VF patch to GSFC via the other side of the HS duplex interface (see figure 10).

Command verification, CAP messages, and site status CAP's received in response to initiated commands shall be received and processed the same as telemetry.

3.7.4 Large Area Crop Inventory Experiment (LACIE) Support. The Earth Resources Interactive Processing System (ERIPS) is a combination of software and hardware implemented at the MCC facility for processing remotely sensed earth resources data. The computing facilities are located in the Real-Time Computer Complex (RTCC) with interactive consoles and display devices located in Bldg. 17. Processing shall be accomplished in both the interactive and production environments to provide maximum flexibility for analysis of data collected in support of the earth resources efforts. The production processing shall support the LACIE in a batch environment by reformatting card input data into simulated interactive inputs. Several data base functions shall be required to support the LACIE data processing application. The data required shall be stored in five functional data bases; i.e., history, fields, imagery, control, and results.

3.7.4.1 Hardware Elements. The ERIPS shall consist of the following hardware:

- 360/75 Computers
- Goodyear Staran Array Processor
- Data base

3.7.4.1 Hardware Elements. (Continued)

- IEODCS
- Alphanumeric DTE devices
- Modified DTE image display devices
- Color monitors
- Hardcopy device
- LACIE Data System Supervisor (LDSS) master terminals.

3.7.4.2 Software Elements. The ERIPS shall consist of the following software:

- a. Operating System. EOS and an interactive supervisor package.
- b. Applications Software. Composed of various packages such as:
 - Data loadings
 - Image registration
 - Pattern recognition
 - Image manipulation
 - Data clustering.

3.7.5 Software Development Lab (SDL) Support. The SDL shall utilize the existing IBM 360/75 complex and shall require the 360/75 Executive Program to support Shuttle onboard software. Display and control equipment shall be required to be implemented and facilities modified to support SDL.

3.7.5 Software Development Lab (SDL) Support. (Continued)

The SDL shall consist of a set of computer programs resident in an IBM 360/75 computer and a hardware configuration.

3.7.5.1 SDL Hardware Elements. For purposes of this document the SDL is defined as consisting of three each of the following special hardware items:

- Flight Equipment Interface Device (FEID)
- AP101 Flight Computer with Input/Output Processor (AP101/IOP)
- Multifunction CRT Display System (MCDS)
- Mass Memory (MM)
- Display Electronics Unit (DEU).

3.7.5.2 MCC Support Hardware. The three sets of equipment in the SDL shall be configurable to any three of the five 360/75 computers in the RTCC or the three sets can be logically configured to one 360/75. The MCC equipment required to support the SDL shall be as follows:

- Two 2914 switch units
- Three 2701 data adapter units with two PDA's
- Three 2848 control units
- Six 2260 display terminals
- Two HAL compiler print trains
- Three communication keysets.

3.7.5.3 SDL Software Elements

- a. Applications Software. The SDL software shall consist of SDL programs that run in the 360/75 under the EOS, FEID operational software and AP101/IOP/MCDS operational software. A block diagram of the MCC/SDL configuration is shown in figure 11.
- b. Operating System. The operating system in the 360/75 is EOS which shall be upgraded to provide features required by all MCC users. For checkout and test purposes, the Combined Operational Hardware and Readiness Testing (COHART) Program shall perform diagnostic and readiness tests on the SDL. COHART shall execute under the EOS in the 360/75.

3.7.6 Display Retrieval and Formatting Technique (DRAFT) Support. The DRAFT D/C System shall provide the capability of generating the DTE background displays to be formatted on disk pack storage for DTE access. The system shall include the following major subsystems:

- Background generation consoles
- Video printer
- DRAFT logic cabinet.

DTE background displays are generated utilizing the DRAFT System in conjunction with the DCC 360/75 computers. Displays are generated, formatted, and edited as required, and a manual select keyboard (MSK) number is assigned.

3.7.7 Natural Environment Support. Conventional natural environment information shall be used by personnel in the Natural Environment Support Room (NESR). Space environment data shall be provided by various National Oceanic and Atmospheric Administration (NOAA) and Air Weather Service (AWS) organizations which will



Figure 11 MCC/SDL Equipment Configuration

3.7.7 Natural Environment Support. (Continued)

exist during the Shuttle era. The NESR shall support Shuttle operations with information concerning space environment radiation hazards and meteorological conditions throughout the world. Real-time reports shall be provided in the following areas:

- Major solar flares
- Major flare X-ray events
- Major flare radio bursts
- Geomagnetic storms
- Artificial events
- Energetic particle reports.

Much of the above data is currently available in the MCC through the domestic teletype, facsimile, and National Weather Service (NWS) keyboard cathode ray tube (CRT) circuits. Present communications systems shall be replaced by more sophisticated systems under development.

3.7.8 Special Purpose Processor (SPP) Support. The SPP is a special purpose processor installed in the RTCC. An associative array processor, the SPP shall be used primarily to process LACIE data and shall be interfaced to the 360/75 computers. The SSP hardware configuration shall be:

a. Goodyear STARAN System consisting of:

- Associative Array Processor (AP)
- PDP-11/20 CPU
- 1.2 MB disk drive (cartridge type)
- DECwriter I/O device

3.7.8 Special Purpose Processor (SPP) Support. (Continued)

- Paper tape reader/punch
- Line printer
- Card reader.

b. SPP interface with 360/75 via 2914 channel software.

3.8 OFT/OPS Transition. The transition period from Shuttle Orbital Flight Testing (OFT) to Shuttle Operations (OPS) shall bring about major changes to MCC operations and resources. The time period from second quarter 1980, to fourth quarter 1981 is denoted as "Transition Period" for the Space Shuttle Program. It is noted, however, that the "Transition" of the MCC to support Shuttle activities is currently in progress and shall continue to evolve until Space Transportation System (STS) maturity. The MCC shall continue to support other programs while the development of Shuttle continues.

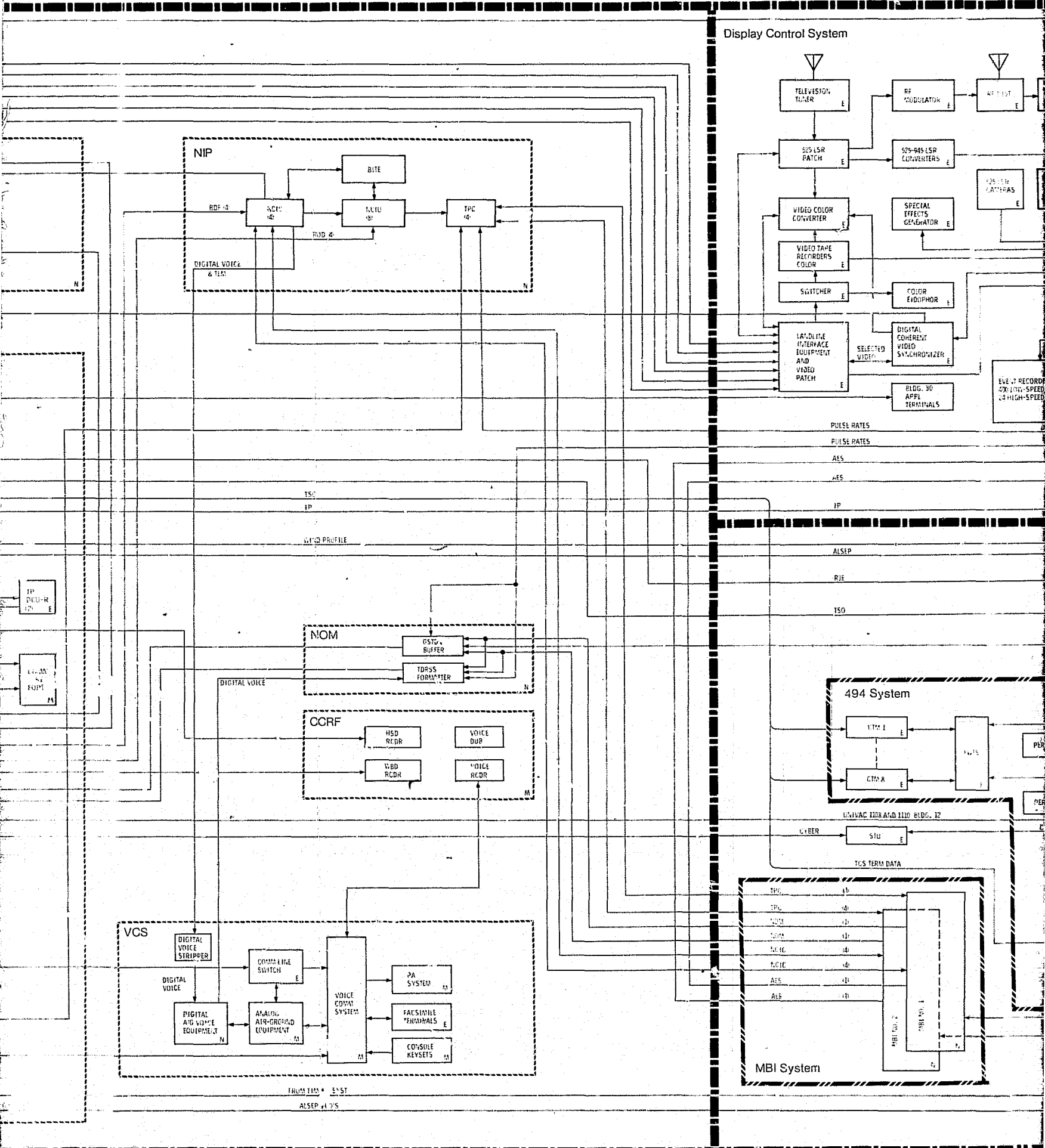
Changes which are expected to occur over the "Transition" period are:

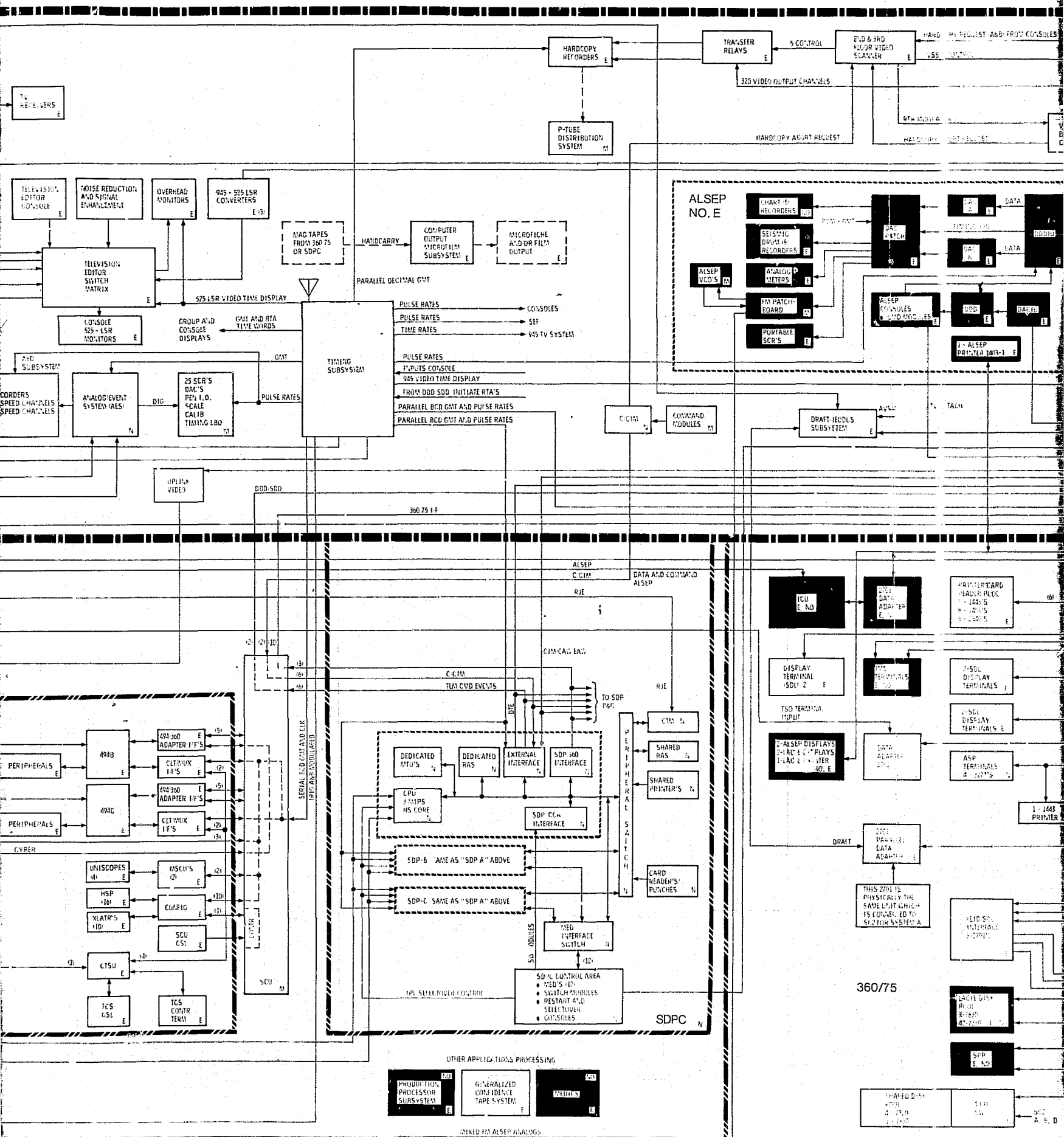
- a. TDRSS Operational. TDRSS is expected to be launched in FY 1980. The initial system will be limited to S-band capability. High-bit rate Ku-band capability will not be available immediately. During first quarter CY 1981, full bit rate capability is expected to be implemented for operational support.
- b. Shuttle Online Data Base. The MCC will implement an online data base in support of Shuttle during the OFT/OPS transition period. The data base must be operational at the beginning of the OPS time-frame. This implies that implementation of this system should begin in second quarter 1979. The data base is projected to be part of the SDPC.

3.8 OFT/OPS Transition. (Continued)

- c. Terminal Applications Support System (TASS) Implemented Within SDPC. The MCC terminal system shall be implemented within the SDPC during second quarter 1981. This system shall encompass all terminal operations.
- d. Removal of U494 Computers From MCC. The current TCS which resides within the U494 computers will be phased out with the implementation of TASS on the SDPC. The U494 computers and peripherals supporting the Terminal System will be removed from the MCC.
- e. Multiple Vehicle Processing Capability. MCC processing capability shall be expanded to allow increased data loads imposed by multiple vehicle support. The following expansions shall be required:
 - Two additional TPC's to handle multiple data sources from multiple vehicles
 - Two additional SDPC computers and reduction of 360/75's
 - Update and expansion of the DCS
 - MCC control and support room reconfiguration to four Flight Control Rooms (FCR's), 12 Multipurpose Support Rooms (MPSR's), and one Mission Operations Planning Room (MOPR)
 - Expansion of the MBI.
- f. Payload Processing Center Implementation. The MCC shall provide resources to implement host payload processing centers if required.
- g. Phase-out of ALSEP Program. It is expected the ALSEP program will be phased out during the transition period.







Data Computation Complex

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4.2 Communication Interface System (CIS). (Continued)

and configuration data for transmission to the SDPC, and extracting telemetry data and preprocessing individual vehicle data for transmission to the SDPC.

- c. Network Output Multiplexer (NOM) Subsystem. The NOM shall accept outgoing network data from the SDPC, add digital voice when required, and interface the STDN (both GSTDN and TDRSS).
- d. Dump Data Processing Subsystem (DDPS). The DDPS shall accept high-rate dumps of onboard data and provide reformatting and reordering of data segments to permit MCC processing.
- e. Voice Communications Subsystem (VCS). The VCS shall provide voice communications among MCC operating positions, and between these operating positions and external locations. It shall also provide public address coverage of the MCC and A/G communications with the Orbiter.
- f. Consolidated Communications Recording Facility (CCRF). The CCRF shall record all data into and out of the MCC, and permit replaying the recorded data or externally supplied tapes for MCC data evaluation.

The block diagram of the CIS is shown in figure 13. Each subsystem is specified in greater detail below.

4.2.1 Communication Circuit Technical Control Facility.
The CCTCF shall consist of the following elements required to interface locations external to the MCC with complementary internal MCC systems. Types, quantities, and locations of interfaces shall be as shown in figure 13 and as described in the following paragraphs.

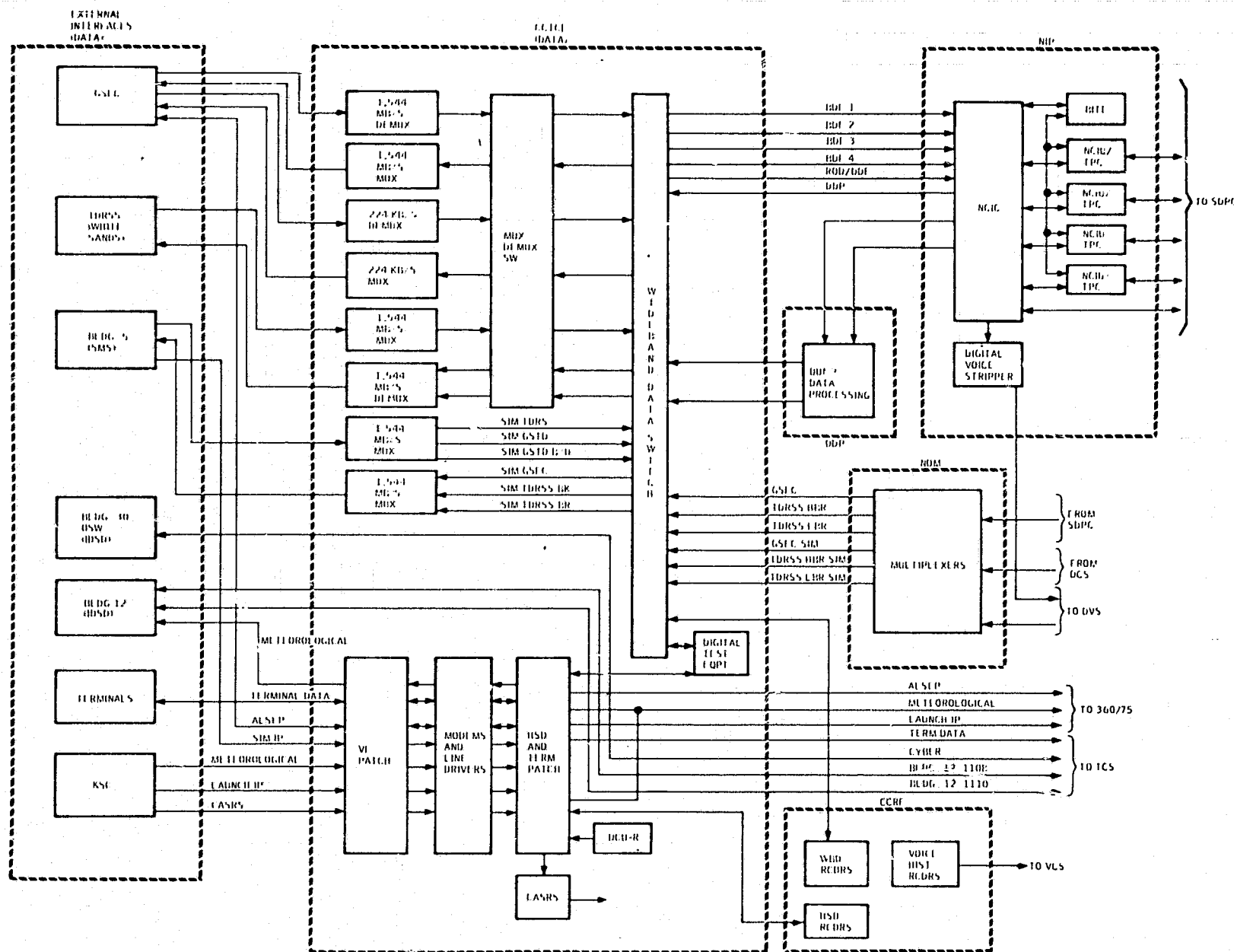
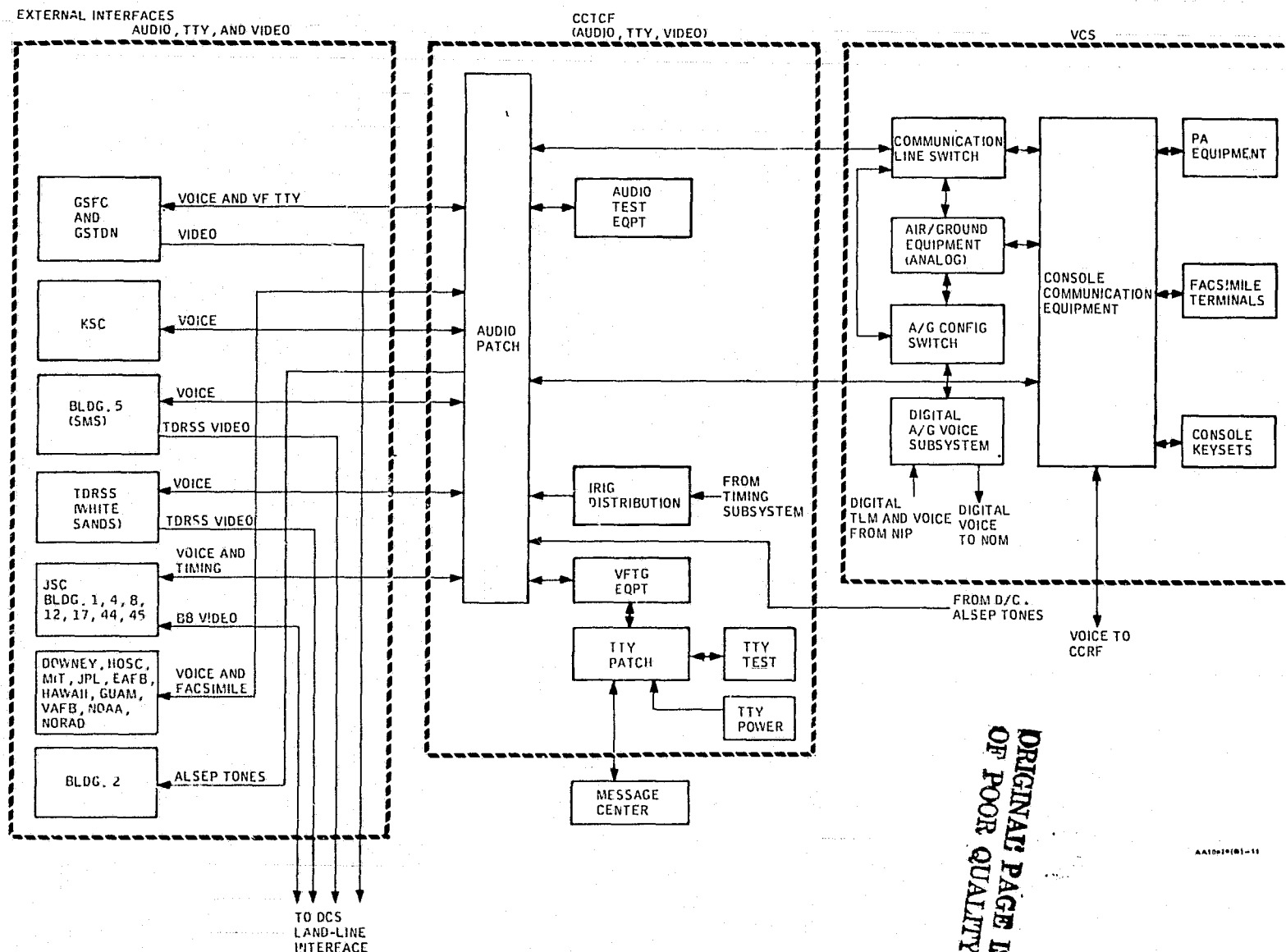


Figure 13 CIS Block Diagram (1 of 2)

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Figure 13 (2 of 2)

4.2.1 Communication Circuit Technical Control Facility.
(Continued)

- a. Audio Patch and Test Facility. This facility shall provide access to audio circuits for testing, monitoring, and restoration.
- b. Teletype Patch and Test Equipment. This equipment shall provide access to TTY circuits for testing, monitoring, and restoration.
- c. HSD Patch and Test Facility. This facility shall provide access to HSD circuits for testing, monitoring, and restoration.
- d. WBD Switching and Test Equipment. This equipment shall provide access to WBD circuits for testing, monitoring, and restoration.
- e. Terminal Patch and Test Facility. This facility shall provide access for low-speed and high-speed terminal circuits for testing, monitoring, and restoration.

4.2.1.1 Audio Circuits

4.2.1.1.1 Functional Description. Audio circuits shall be provided between the MCC and locations external to the MCC. These circuits shall be 4-wire full-duplex circuits with nominal 0 dBm test tone level (TTL) and -8 dBm speech power level (SPL). The circuits shall be routed to and from the MCC through the Audio Patch and Test Facility located in the CCTCF. This facility shall provide capability for monitoring, testing, and cross-patching up to 260 4-wire and 78 2-wire audio circuits entering

4.2.1.1.1 Functional Description. (Continued)

and leaving the MCC. The patch facility shall provide access to the external lines and the MCC audio systems; the test facility shall provide the capability to test circuit performance. Circuits routed through this facility are 4-wire voice communication circuits used for mission operations and support. These circuits provide all voice communications with locations external to the MCC, with the exception of Private Automatic Branch Exchange (PABX) telephone service.

4.2.1.1.2 Interfaces

a. Private Wire Telephone Service Interface (NASCOM Voice Circuits)

(1) Operational Interface. The NASCOM voice lines shall be used as follows:

- Point-to-point communications between the MCC and the NASCOM sites for operational messages such as status reports, equipment failures, etc.
- A/G control functions accompanying the voice to certain NASCOM sites for the purpose of controlling A/G transmitter keying circuits when in communication with the spacecraft.

(2) Physical Interface. All NASCOM 4-wire lines shall be terminated by the Telephone Company (Telco) on the Telco main distribution frame (MDF), and cross-connected by Telco to a Telco-supplied tie cable. The point of physical interface shall be the end of the tie cable which is terminated by NASA on a NASA frame located in the CCTCF.

4.2.1.1.2 Interfaces. (Continued)

- (3) Electrical Interface. The normal TTL (send and receive) measured at the physical interface shall be 0 dBm and adjustable within ± 3 dB.

b. VCS Interface

- (1) Operational Interface. Same as NASCOM circuits.
- (2) Physical Interface. All NASCOM 4-wire voice circuits shall be cross-connected through normal-through jacks to a Cable Termination Cabinet (CTC) in the CCTCF. From the CTC the circuits shall be cross-connected by a tie cable to the MDF in Room 127A. The end of the tie cable, terminated by NASA on the 127A MDF, shall be the point of physical interface.
- (3) Electrical Interface. Same as NASCOM circuits.

c. Timing Subsystem (TS) Interface

- (1) Operational Interface. Digital time-of-day signals shall be distributed by the Communications System (CS) to various internal components on two lines from the DCS.
- (2) Physical Interface. The two lines from the DCS shall be terminated on the distribution frame located in the CCTCF.
- (3) Electrical Interface. The signal at the point of physical interface shall be an IRIG-B modulated GMT signal, with a peak-to-peak amplitude of 4 volts [1.4 V root mean square (rms)] when terminated in 75 ohms. The impedance shall be 75 ohms, balanced to ground, in either direction.

4.2.1.1.2 Interfaces. (Continued)

d. IRIG-B Timing Distribution Interface

- (1) Operational Interface. Digital time-of-day signals shall be distributed by the CS to various Bldg. 30 users and to outside users in various other JSC buildings.
- (2) Physical Interface. Fourteen signal outputs shall be terminated through normal-through jacksets in the audio patch bay and cabled to the CCTCF distribution frame.
- (3) Electrical Interface. The signal at the point of physical interface shall be an IRIG-B modulated GMT signal adjustable to +17 dBm. The output impedance of each circuit shall be 600 ohms and may be balanced or unbalanced to ground.

e. VFTG Interface

- (1) Operational Interface. The VFTG shall consist of an AN/FCC-25 which is a frequency division multiplexer (FDM) providing transmission and reception of telegraph signals over voice frequency transmission channels.
- (2) Physical Interface. Two 4-wire voice circuits shall be cross-connected through normal-through jacksets to a NASA frame located in the CCTCF. From the frame, the two circuits shall be cross-connected to the cable terminated in two sets of VFTG equipment.
- (3) Electrical Interface. Levels measured at the physical interface shall be nominally -8 dBm send and receive TTL's, adjustable within ± 3 dB. Impedance shall be 600 ohms balanced to ground. Nominal frequency response shall be 3 kHz.

4.2.1.1.2 Interfaces. (Continued)

f. Central Power Interface

- (1) Operational Interface. The Room 127A central power supply shall provide -48 V dc signalling and lamp power.
- (2) Physical Interface. The Room 127A main distribution fuse panel shall provide a 2-wire connection to a CCTCF fuse distribution panel located in an audio patch bay.
- (3) Electrical Interface. The electrical interface shall consist of a -48 V dc feed capable of providing 30-amp service.

g. CLS Bad Lines Interface

- (1) Operational Interface. A bad line or out-of-service condition indication shall be provided to the CLS by switch closures on the audio patch panels.
- (2) Physical Interface. The CCTCF audio patch modules shall route 180 wires to the CCTCF frame. From the frame, the wires shall be cross-connected to a tie cable terminated on the Room 127A MDF. The wires shall then be cross-connected to a cable terminated at the CLS consoles.
- (3) Electrical Interface. The switch closures on the audio patch modules shall provide grounds to the CLS console causing lamps to be illuminated.

4.2.1.2 Teletype Circuits

4.2.1.2.1 Functional Description. The TTY Test and Patch Equipment, including the TTY loop power supplies and VFTG equipment, shall provide monitoring and cross-patching for all internal and external MCC TTY circuits. TTY shall be 60 or 100 words per minute (WPM), 45.5 or 74.2 baud, 7.42-unit interval start-stop Baudot code. The equipment shall provide loop power and patching access for up to 200 TTY circuits and jack access for the following tests:

- Online monitoring of each NASCOM and direct user receive circuit (a total of 60 monitors shall be provided)
- Distortion measurements
- Distortion analysis
- Standard test messages.

The TTY loop power equipment shall consist of a 130 V dc, 25-amp power system. In addition, the TTY loop power equipment shall provide loop battery current for neutral operation of all NASCOM and internal TTY send/receive circuits. The VFTG terminal equipment shall provide the interface for all TTY circuits between the MCC and GSFC, via two 3-kHz duplex voice channels, and shall accommodate up to 16 full-duplex TTY circuits on a redundant basis.

4.2.1.2.2 Interfaces

a. Telco Private Line Teletypewriter Service Interface

- (1) Operational Interface. These TTY lines shall be used to provide text message traffic between the MCC and all outside users (meteorology, defense communications agency, etc.) except the NASCOM, which interfaces through the VFTG equipment.

4.2.1.2.2 Interfaces. (Continued)

- (2) Physical Interface. Telco shall furnish, install, and terminate TTY circuits on the Telco MDF. In addition, Telco shall provide and install a tie cable to the CCTCF distribution frame. Telco shall provide NASA with the cable count and designate the circuits appearing on the pairs. NASA shall terminate the cable on the frame and make the necessary crossconnects.
- (3) Electrical Interface. The TTY lines shall meet the following electrical requirements:
 - Operating Speeds: 60 or 100 WPM (45.5 or 74.2 baud)
 - Signalling Levels: 60 mA neutral battery power externally furnished by CCTCF; full-duplex circuits shall appear as 4-wire dry lines, and half-duplex circuits shall appear as one 2-wire dry line
 - Character Composition: 7-unit (5-level start/stop); 7.42-unit internal minimum length
 - Line Resistance: Only inherent line and keying relay resistance, with a 200-ohm maximum total.

b. NASCOM Interface

- (1) Operational Interface. All NASCOM TTY circuits entering or leaving the MCC shall be routed through the TTY patch before being routed to their specific users.

4.2.1.2.2 Interfaces. (Continued)

- (2) Physical Interface. These TTY circuits shall be routed from the dc interface of the VFTG equipment by a cable terminated at the NASA frame located in the CCTCF. They shall be cross-connected through the appropriate TTY patch modules back to the frame, then cross-connected to leased TTY machines. All internal TTY machines and associated circuits required by the MCC shall be furnished, installed, and terminated by Telco on the Telco MDF. Telco shall also provide a tie cable to the CCTCF NASA distribution frame. Cable count and designated pair assignments are provided to NASA by Telco. NASA shall furnish the terminal blocks, connect the Telco tie cable to the NASA distribution frame, and make the necessary crossconnects.
- (3) Electrical Interface. Same as Telco Private Line Service.

c. Central Power Interface

- (1) Operational Interface. The Room 127A central power supply shall provide negative 48 V dc for relay and lamp power.
- (2) Physical Interface. The Room 127A main distribution fuse panel shall provide a pair of wires to a Room 118 fuse distribution panel located in the TTY patch bay.
- (3) Electrical Interface. A -48 V dc feed shall be capable of providing 30-amp service.

4.2.1.3 HSD Circuits

4.2.1.3.1 Functional Description. HSD circuits at up to 9600 b/s shall be provided between the MCC and selected locations both internal and external to JSC. External lines, in the form of MODEM VF data, shall be routed to and from the MCC through the data circuit VF patch facility located in the CCTCF. This facility shall provide capability for monitoring, testing, and cross-patching up to 104 full-duplex HSD circuits entering and leaving the MCC. The patch facility shall provide access to the interface between the VF lines and the Telco and GFE MODEM's. Onbase data circuits, not requiring MODEM's, shall appear directly on HSD patch bay jacks, as will the digital (drop) side of the MODEM's for external circuits.

Data routed through the HSD facility shall be in accordance with EIA RS-232 for data rates up to 9.6 kb/s and in accordance with EIA RS-422 for higher data rates. This data shall be:

- Launch and landing data via KSC
- Wind profile data via KSC
- ALSEP data
- CASRS data.

The HSD patch shall provide HSD switching and routing capability as follows:

- a. Launch/Landing Radar Data. Launch/landing radar data shall be switched and routed to/from either of two IBM DCU-R's. The MCC shall receive tracking data from the KSC. The input data from the MODEM interface shall be routed through the HSD patch to one of two DCU-R's. The data shall then be rerouted back through another patch appearance from the output sides of the DCU's for throughput to the IBM 360/75 2902's of the DCC System, where it is input

4.2.1.3.1 Functional Description. (Continued)

to the computer. Data interface logic levels and impedances shall be as stated in Bell System *Data Set 201 Interface Specification*, IBM *Data Control Unit (DCU) Equipment to Bell System Data Set Specification No. 5251639*; *Data Control Unit (DCU) Equipment to Communication Processor Specification No. 5251642*; and *EIA Standard RS-232*.

- b. Wind Profile Data. Wind profile data shall be routed to the HSD patch for output to the 360/75 and to Bldg. 12. Data shall be received from the KSD Weather Information Network Data System (WINDS) via a 201 data MODEM and patched through the HSD patch for output to Bldg. 12 via another 201-type MODEM unit. Data and interface logic levels and impedances shall be as stated in Bell System *Data Set 201 Interface Specification*, and *EIA Standard RS-232*. (The 360/75 interface is TBD.)
- c. ALSEP Command Display Data. This data shall be routed to the HSD patch from a Datran MODEM operating at 9.6 kb/s. Data shall be patched through the HSD patch to the ALSEP 360/75 ICU. Data and interface logic levels and impedances shall be as stated in *EIA Standard RS-232*. The circuit shall be full duplex, and a 7.2 kb/s duplex circuit shall be provided as a backup with the same interface characteristics.
- d. CASRS Data. This data shall be received from KSC via a 201 data MODEM operating at 2.4 kb/s and routed through the HSD patch to the CASRS, where it shall be decoded and routed to appropriate display devices.

High-speed testing equipment is TBS.

4.2.1.3.2 Interfaces

- a. Operational Interfaces. TBD.
- b. Physical Interface. Terminations for the HSD lines are Telco type 201, 203, and 205 data MODEM's, as well as several types of GFE MODEM's and digital line drivers. The physical interface is described for the digital data side of the MODEM or the line drivers.
 - (1) MODEM's. The data interface on each circuit shall be a 25-pin connector on the rear of each MODEM as specified in Bell System, *Data Set 201, 203, and 205 Interface Specification*. Telco MODEM's shall be mounted by Telco in Room 127 in Telco-supplied racks; GFE MODEM's shall be mounted in racks in the CCTCF.
 - (2) Digital Line Drivers and Terminators. These interfaces are TBS.
- c. Electrical Interface. Data interface logic levels and impedance shall be as stated in Bell System, *Data Set 201, 203, and 205 Interface Specification*, and *EIA Standard RS-232*.

4.2.1.4 WBD Switching Circuits. TBS.

4.2.1.5 Terminal Patch and Test Facility

4.2.1.5.1 Functional Description. The Terminal Patch and Test Facility shall route operational and test data to/from the computer interface terminals to the TCS Processor. Jack access shall be provided by the digital patch bays for up to 312 digital circuits, made up of the Bell MODEM's, NASA digital MODEM drivers or direct terminals. VF jack access shall be provided by the VF patch bays for up to 192 circuits, made up of Bell MODEM's or NASA-owned MODEM drivers. A telephone ringdown panel shall provide the capability of terminating up to 120 ringdown voice/data circuits. Test equipment shall be provided through jack access to perform the following tasks:

- Audible monitoring of modem VF inputs/outputs
- Frequency response measurements
- Level measurements
- Test tone generation
- Visual presentation of VF and digital signals and level measurements
- Test message generation and reception
- Bit-by-bit error-checking of the test message.

4.2.1.5.2 Interfaces

- a. Operational Interface. The Patch and Test Facility shall provide for the termination, control, evaluation, and test access to all terminal circuits entering and leaving the TCS Processor.

4.2.1.5.2 Interfaces. (Continued)

- b. Physical Interface. Circuits shall terminate on jacksets which are a part of the Terminal Patch and Test Facility. These circuits shall continue through to the TCS Processor either on a normal-through basis or on a patch access depending on the type of use the terminal is allocated by NASA.
- c. Electrical Interfaces. Two types of interfaces shall be provided for by the Terminal Patch and Test Facility:
 - (1) VF. The VF interface shall consist of two forms: Bell MODEM with TTL's of -8 dBm at 1,000 Hz, and normal data levels at -16 dBm. Impedance shall be 600 ohms. NASA-owned MODEM drivers shall be 4-wire circuits rated as follows for different drive distances.
 - Up to 5 miles, wire size 19 or 22 American Wire Gauge (AWG)
 - Up to 3 miles, wire size 24 AWG
 - Up to 2 miles, wire size 26 AWG
 - (2) Digital. All digital interfaces shall be in accordance with *EIA Standard RS-232*.

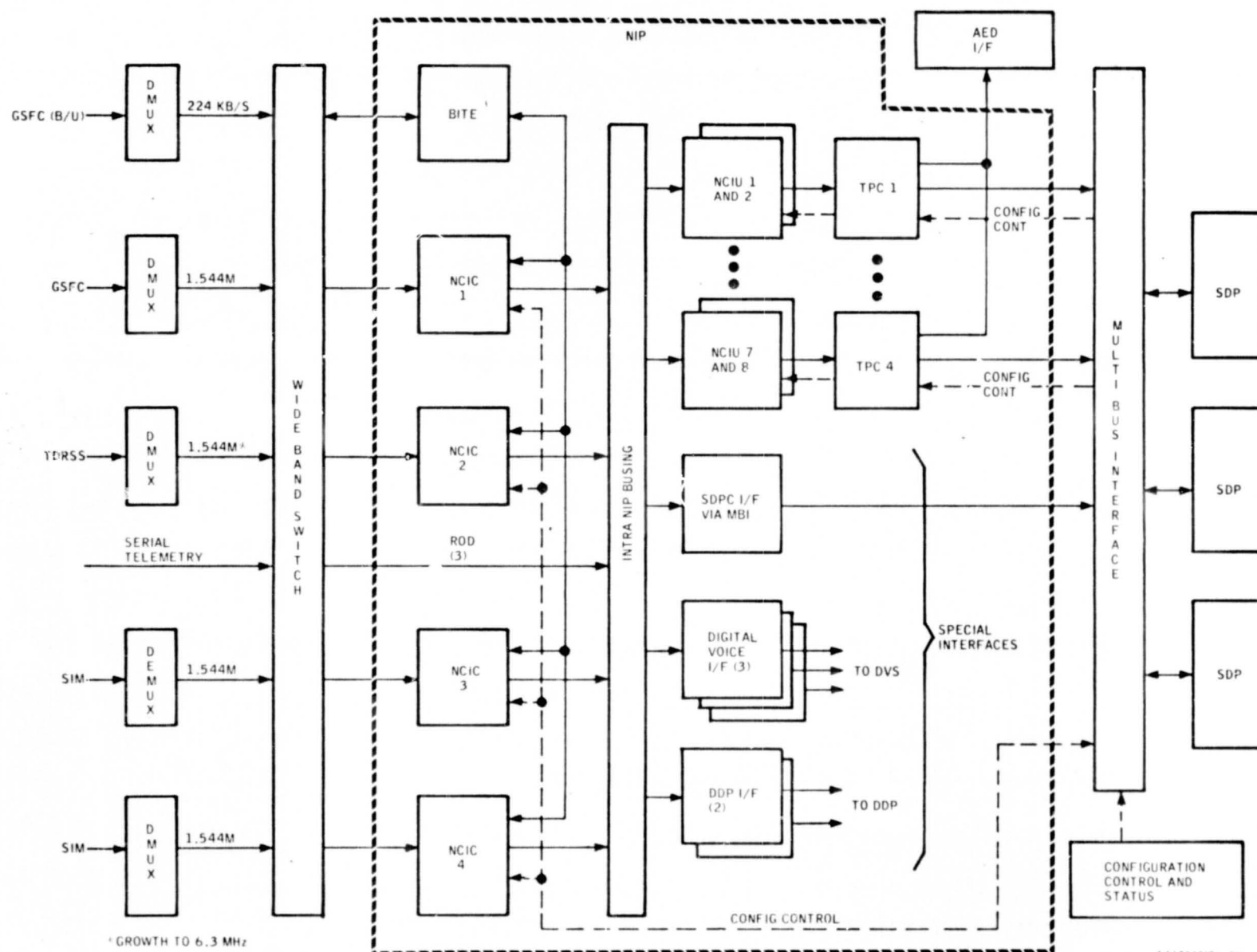
4.2.2 Network Interface Processor (NIP) Subsystem. The NIP shall perform a generalized communications interface and routing function for Orbiter and associated payload telemetry data, and tracking site data. Prior to routing telemetry data, processing shall be performed to compensate for idiosyncracies in Orbiter-generated downlink data, permitting more conventional decommutation techniques to be utilized for subsequent processing of telemetry data by other MCC subsystems.

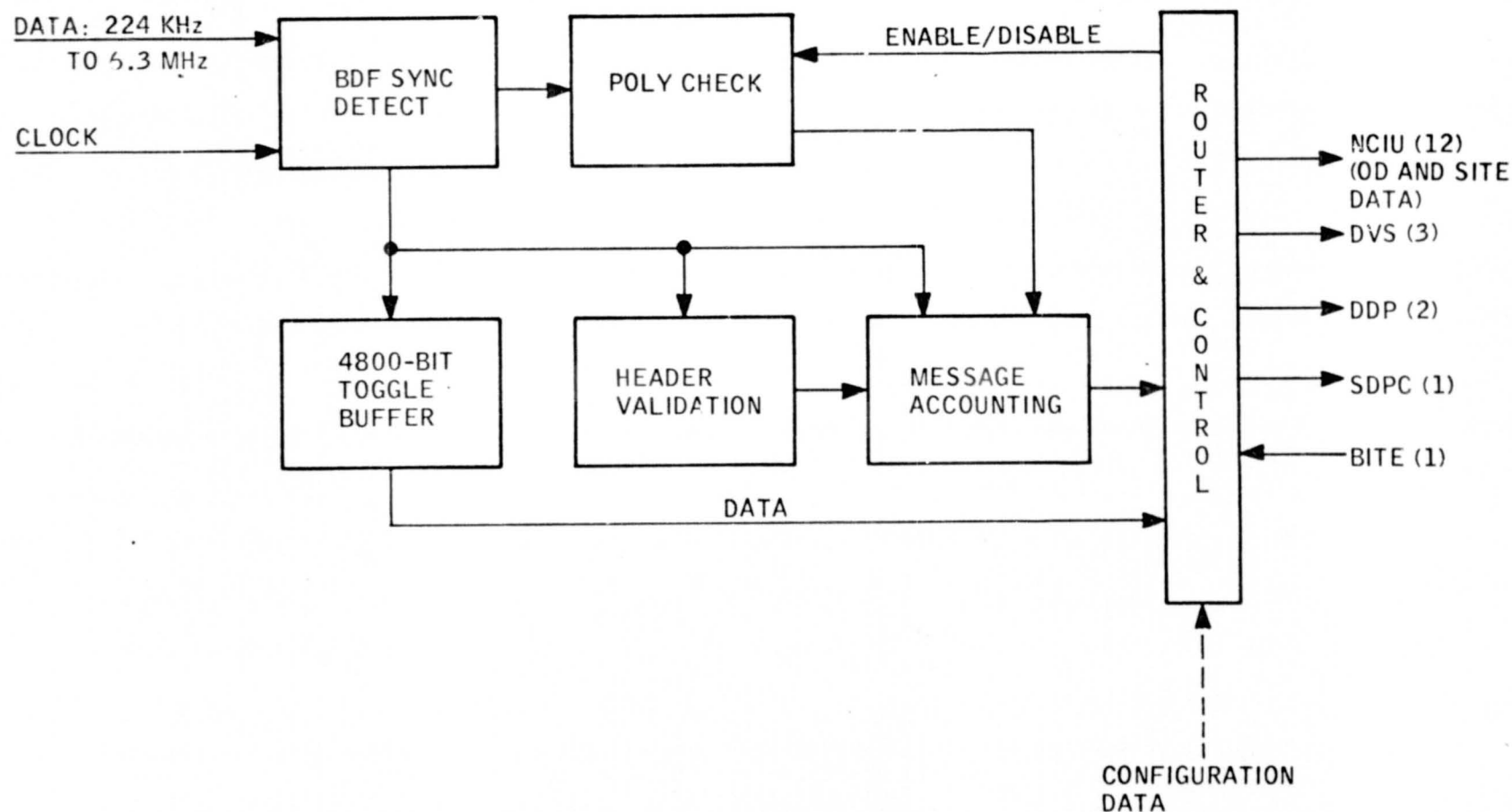
4.2.2 Network Interface Processor (NIP) Subsystem.
(Continued)

A block diagram of the OFT NIP Subsystem is presented in figure 14. Only those elements contained within the dashed boundary are part of the NIP Subsystem; the other elements are included to clarify the relationship of the NIP to DCS, DCC, and other CIS subsystems.

The major elements of the NIP and a summary of their functions are described below and these functions are described in greater detail in following paragraphs.

- a. Network Communications Interface Common (NCIC). The NCIC (figure 15) shall be the network input interface for the NIP Subsystem and shall perform the following major functions:
 - Network block synchronization
 - Block buffering
 - Polynomial encoding/checking
 - Block header validation
 - Block message accounting
 - Block data and route demultiplex
 - Configuration/reconfiguration of validation and routing parameters.
- b. Network Communication Interface Unique (NCIU). The NCIU (figure 16) shall handle a single telemetry data stream and its associated site status data. The data may either be in a blocked format from an NCIC or in a serial bit contiguous format from the





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Figure 15 Network Communications Interface Common

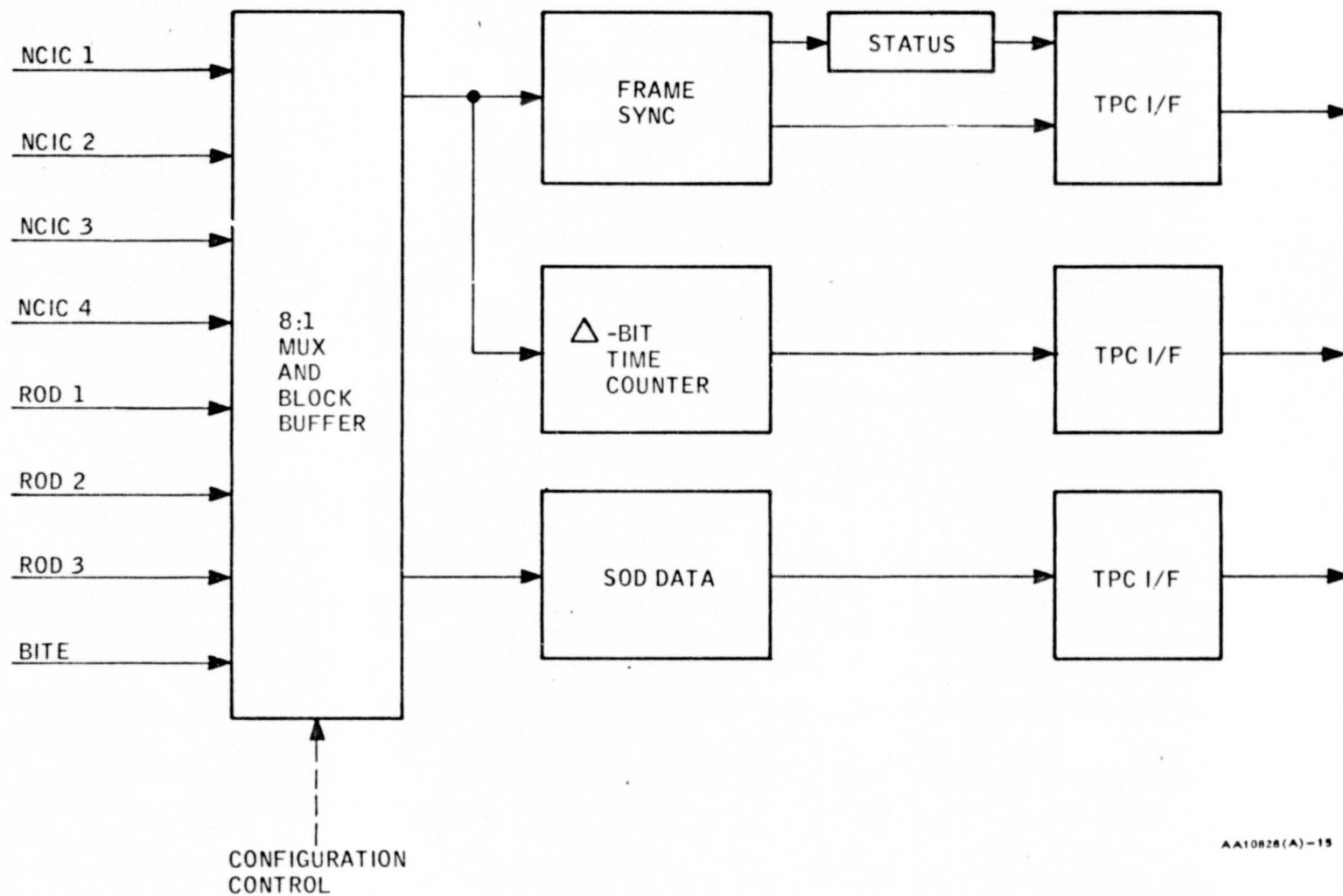


Figure 16 Network Communication Interface Unique

4.2.2 Network Interface Processor (NIP) Subsystem.
(Continued)

Wideband Recording Subsystem. The following synchronization and data handling functions shall be performed by the NCIU:

- Reduce network data rates to transfer rates compatible with TPC processing
 - Select between block and bit contiguous input formats
 - Perform A/G frame synchronization
 - Compute delta times for blocked data
 - Transfer A/G data buffers to TPC
 - Transfer A/G frame synchronizer status to TPC
 - Transfer site data buffers to TPC
 - Configure/reconfigure input multiplexing and synchronization parameters.
- c. Intra-NIP Busing. This function is shown as an independent element in the block diagram (figure 14) primarily to simplify the drawing and at the same time illustrate that any NCIC or ROD input can be routed to any of the NCIU or special interfaces. The allocation of NIP Subsystem functions is not complete at this time. However, it appears that most of the busing functions will be distributed between the NCIC output routing and the NCIU input multiplexer and not as a specific element of the NIP Subsystem.

4.2.2 Network Interface Processor (NIP) Subsystem.
(Continued)

- d. Special Interfaces. These interfaces indicated in figure 14 share functions in common with the NCIU but shall be considered special because they output to MCC subsystem elements other than a TPC and incorporate functions which differ from the standard NCIU functions. Each of the special interfaces shall contain standard NCIU functions for interfacing with the intra-NIP busing and incorporate buffering to reduce the network data to rates optimized for transfer to the using subsystem element. Additional functions for the special interfaces shall be as listed below.
- (1) MBI/SDPC Interface. This element shall contain all functions necessary to transmit data blocks to the SDPC via the MBI, transmit/receive status messages, and any other MBI protocol requirements.
 - (2) DVS Interface. Each of the three interface elements shall contain functions necessary to accept network BDF from the NCIC and regenerate a serial bit contiguous 192 kb/s output to the DVS.
 - (3) DDP Interface. Two of these interface elements shall be provided to permit handling dump data from two sources simultaneously. Each of these elements shall accept BDF from the NCIC and incorporate all functions to transfer the data to the DDP.

4.2.2 Network Interface Processor (NIP) Subsystem.
(Continued)

- e. NIP Built-in Test Equipment (BITE). The BITE (figure 17) shall provide checkout and monitoring capability to verify proper operation of the NCIC and NCIU hardware. The BITE shall be composed of a GFE PDP 11/20, associated interface equipment, and peripherals as indicated in the referenced figure. The major functions of the BITE are listed below:
- Interface with multiple NCIC's and NCIU's
 - Test NCIC by generating blocked messages with poly, simulating error conditions in header, scoring tests, displaying test parameters, and providing test logging and delogging.
 - Test NCIU by generating unblocked serial test data and simulating error conditions.
 - Perform online selective logging of network blocks for troubleshooting.
- f. Telemetry Preprocessing Computer (TPC) Configuration. The general TPC configuration, I/O structure, peripheral complement and special I/O interfaces are represented in figure 18. The functions and applications of standard CPU peripheral devices are discussed in paragraph 4.2.2.4 relative to TPC processing functions. The major functions of the special I/O interfaces are described below.
- (1) MUX Bus Special Interface. Data transfer to/from the TPC, all functions necessary to input time from the Master Instrumentation Timing Equipment (MITE), and all functions necessary to generate an IRIG-B formatted TPC time output shall be incorporated in this interface.

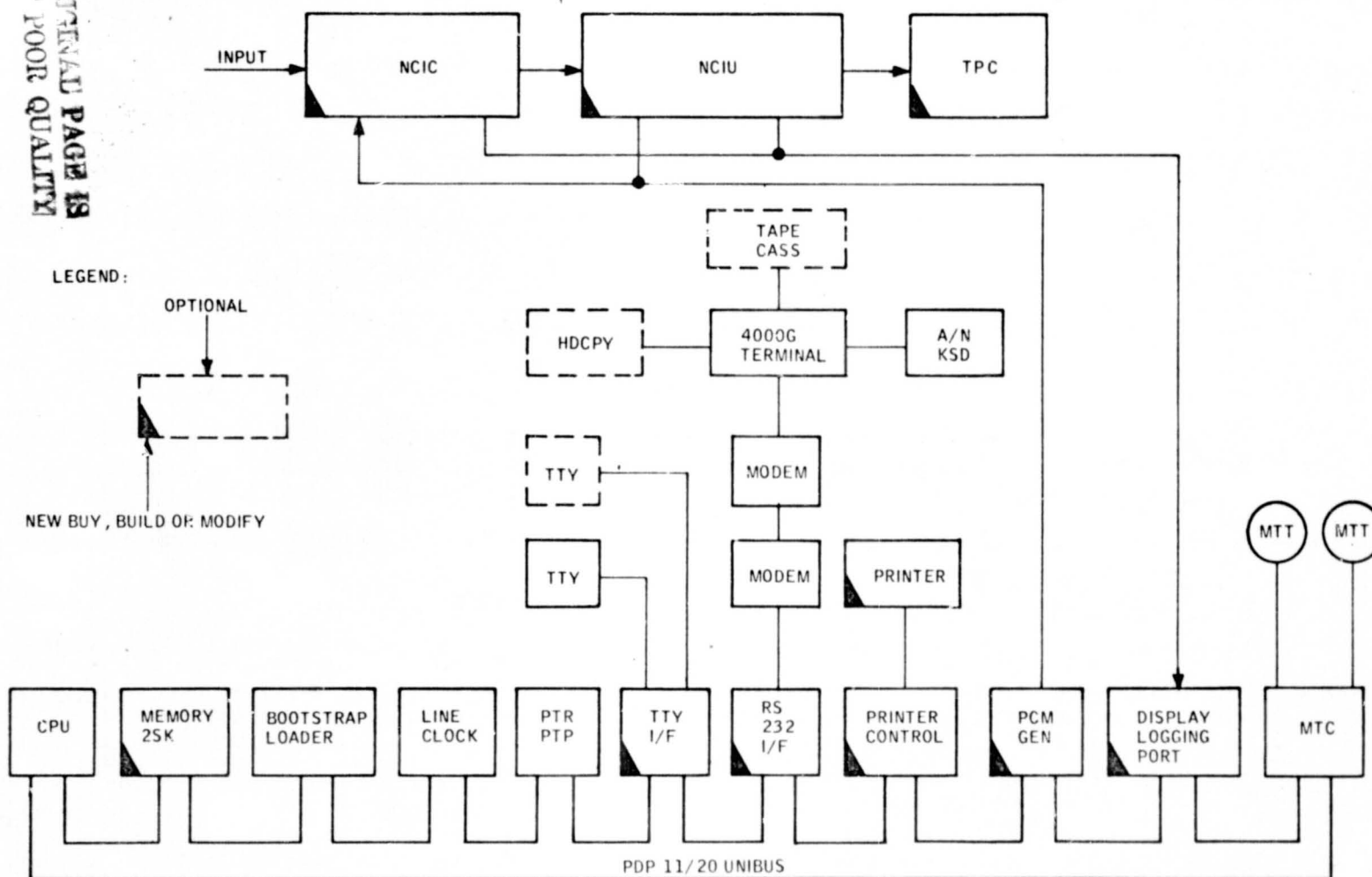


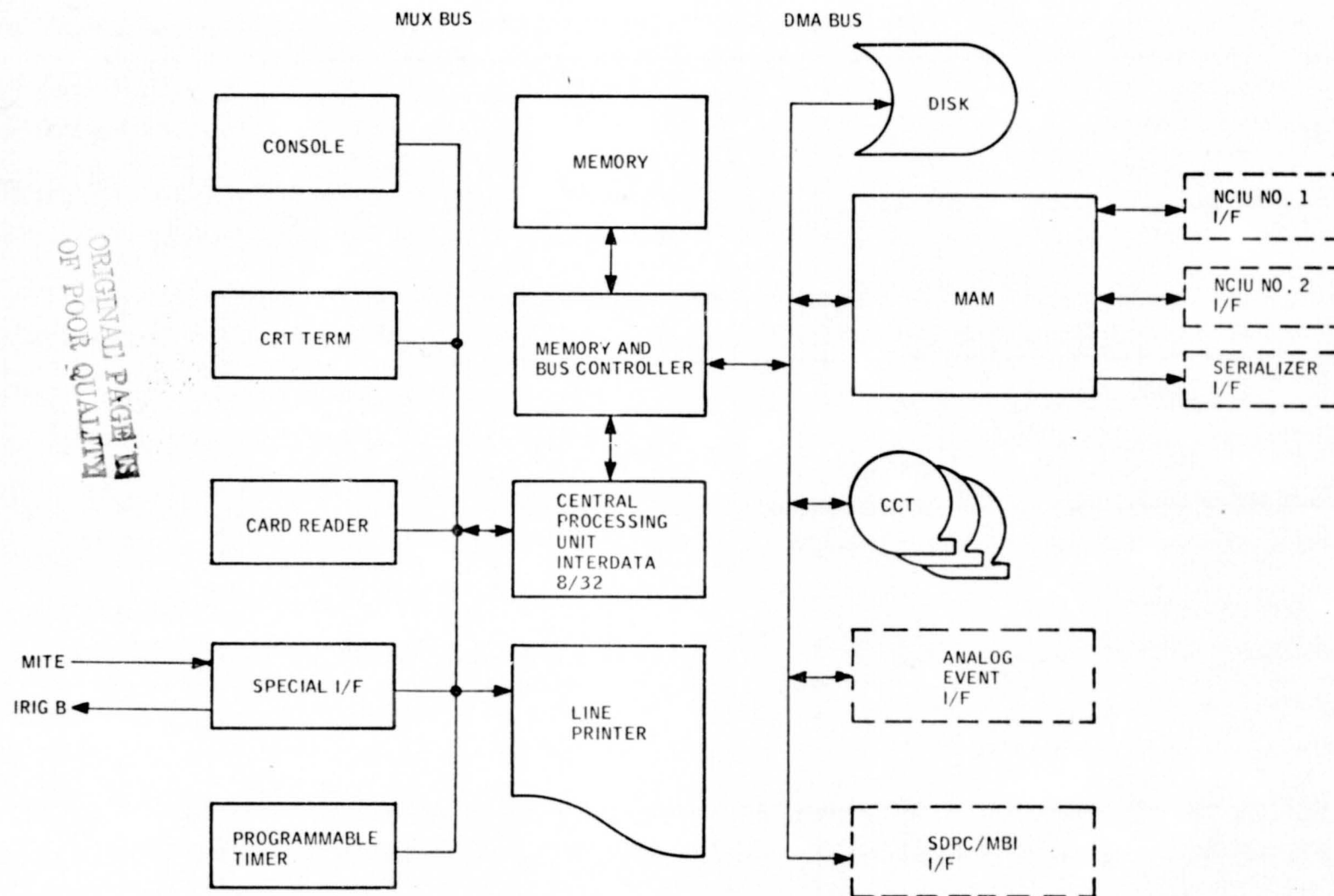
Figure 17 NIP Built-In Test Equipment

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OPTIONAL

NEW BUY, BUILD OR MODIFY



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Figure 18 Telemetry Preprocessing Computer

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4.2.2 Network Interface Processor (NIP) Subsystem.
(Continued)

- (2) Memory Access Multiplexer (MAM). This is a special I/O interface supplied by the computer manufacturer as an option. It shall allow high-speed interleaving of external data into memory under direct memory access (DMA) control. The data to/from two NCIU's and the serializer shall be buffered in and out of memory via the MAM.
- (3) NCIU Interface. This interface shall combine standard TPC interface functions with all special functions necessary to transfer telemetry, site, hardware status, and configuration data between the TPC and NCIU. Separate interfaces shall be provided for two NCIU's.
- (4) Serializer Interface. This interface shall combine standard TPC interface functions with all special functions necessary to generate a variable rate serial data format from data transferred in parallel format from the TPC.
- (5) SDPC/MBI Interface. Standard TPC interface functions shall be incorporated with all functions necessary to transmit/receive data blocks to/from the SDPC via the MBI, transmit/receive status messages, and any other MBI transmission protocol requirements.
- (6) AED Interface. This interface shall combine standard TPC interface functions with all special functions necessary to transmit selected parameter values, sample ID, and status information to the AED.

4.2.2 Network Interface Processor (NIP) Subsystem.
(Continued)

g. TPC Processing. The TPC software shall incorporate all functions necessary to meet the following general telemetry processing requirements.

(1) Provide a generalized decommutation service for a wide variety of telemetry formats within the following limits:

- Maximum bit rate - 128 kb/s
- Maximum frame length - 8192 bits/frame
- Maximum frame rate - 200 frames/second
- Maximum word size - 16 bits/word
- Maximum number of subcoms - five.

(2) Process the following data types:

- Operations downlink (real-time, playback, and dump)
- Interim upper stage (IUS) downlink
- Development flight instrumentation (DFI) playback dump
- Site-originated data (SOD)
- Payloads
- NCI ground receipt time, configuration, and processing statistics.

4.2.2 Network Interface Processor (NIP) Subsystem.
(Continued)

This data may be from the TDRSS, STDN, SAIL/ESTL, OAS/SMS or instrumentation tapes; it shall be input, validated, decommutated and output. See figure 19 for a summary of the flow of TPC processing.

(3) Output formatted data with the appropriate header information to:

- SDPC
- AED
- IDSD/Full Rate THRIFT (CCT)
- Processing advisories
- NIP status/index information
- Serializer.

h. Configuration Control. The online configuration control function of the NIP is shown by dashed lines in figure 14. The representation assumes that regardless of which MCC subsystem is allocated the configuration management function, the interface with NIP shall be via the MBI. The necessary interface requirements shall be incorporated in the NCIC, and the NCIU configuration data routing shall be via the TPC and its MBI interface. The major functions for these two paths of configuration control are listed below. Manual override and offline maintenance controls shall be provided for selected configuration functions.

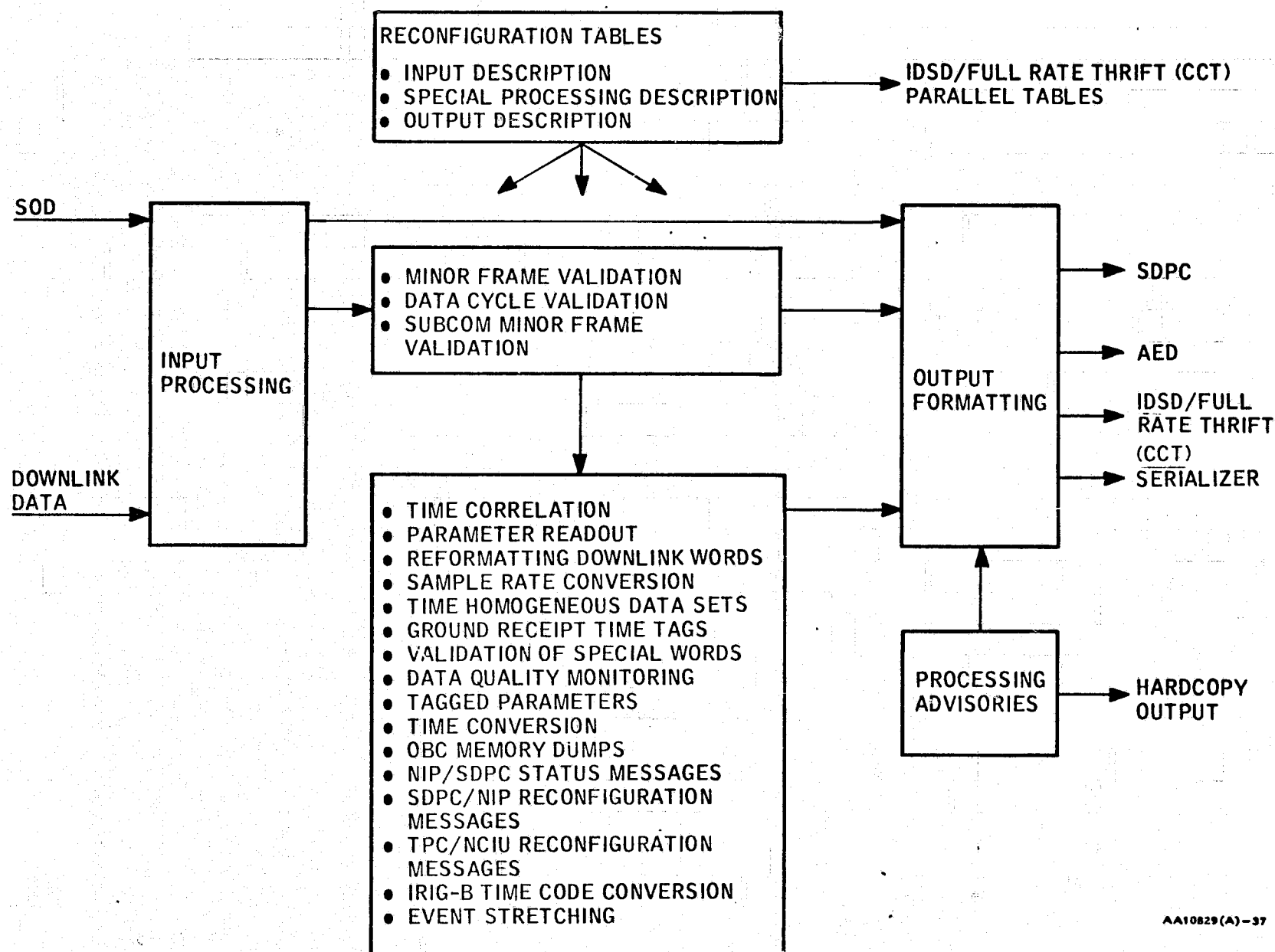


Figure 19 TPC Processing Flow

4.2.2 Network Interface Processor (NIP) Subsystem.
(Continued)

(1) TPC-routed configuration functions shall provide the following:

- Tables defining processing and output formatting of telemetry data
- Tables of parameters to be output to the AED
- NCIU telemetry frame synchronization parameters
- NCIU data multiplexing commands
- Configuration status messages.

(2) NCIC configuration functions shall provide the following:

- Data routing
- Data inhibit/enable
- NASCOM header ID fields
- Poly code check inhibit/enable
- Validation tolerances.

4.2.2.1 NCIC. TBS.

4.2.2.2 NCIU. TBS.

4.2.2.3 Special Purpose NCI Interfaces. TBS.

4.2.2.4 TPC. TBS.

4.2.2.5 Reconfiguration. TBS.

4.2.3 Network Output Multiplexer (NOM). The NOM shall provide the output interface between the MCC and the STDN. The NOM shall accept data blocks containing commands, acquisition data, site commands, etc. from the SDPC via the MBI and transmit the data block serially in the NASCOM format to the selected port of the GSTDN Multiplexer (MUX). The NOM shall accept data blocks containing Orbiter command or computer load data from the SDPC via the MBI, and shall time-division multiplex the SDPC data with digital voice, digital text, and graphics data to provide continuous synchronous serial Shuttle uplink formats to the TDRSS MUX. (See figure 20).

4.2.3.1 GSTDN Block Transfers. The NOM shall accept output data blocks from the SDPC, provide double buffering of the SDP blocks, and serialize the data for transmission to the GSTDN MUX. The NOM shall route data to one port (GSFC) of the GSTDN MUX for pre-TDRSS OFT and to six ports (GSFC, plus five sites) of the GSTDN MUX for post-TDRSS OFT and OPS.

The SDP output block to the NOM shall contain only NASCOM header and output data. The NOM shall provide fixed NASCOM header and data fill required to complete a 4.8K bit NASCOM block. The NOM shall format and output one NASCOM block for each SDP input block.

The NOM shall provide GSTDN block data output hardware to support operations and simulations, and to back up the operational hardware, as a minimum. NOM internal hardware shall be manually assigned to operational or simulation output ports. Routing of SDPC data to NOM internal functions shall be provided by an SDP ROUTING field in the data block, designating the NOM output port (MUX input port) for the selected block.

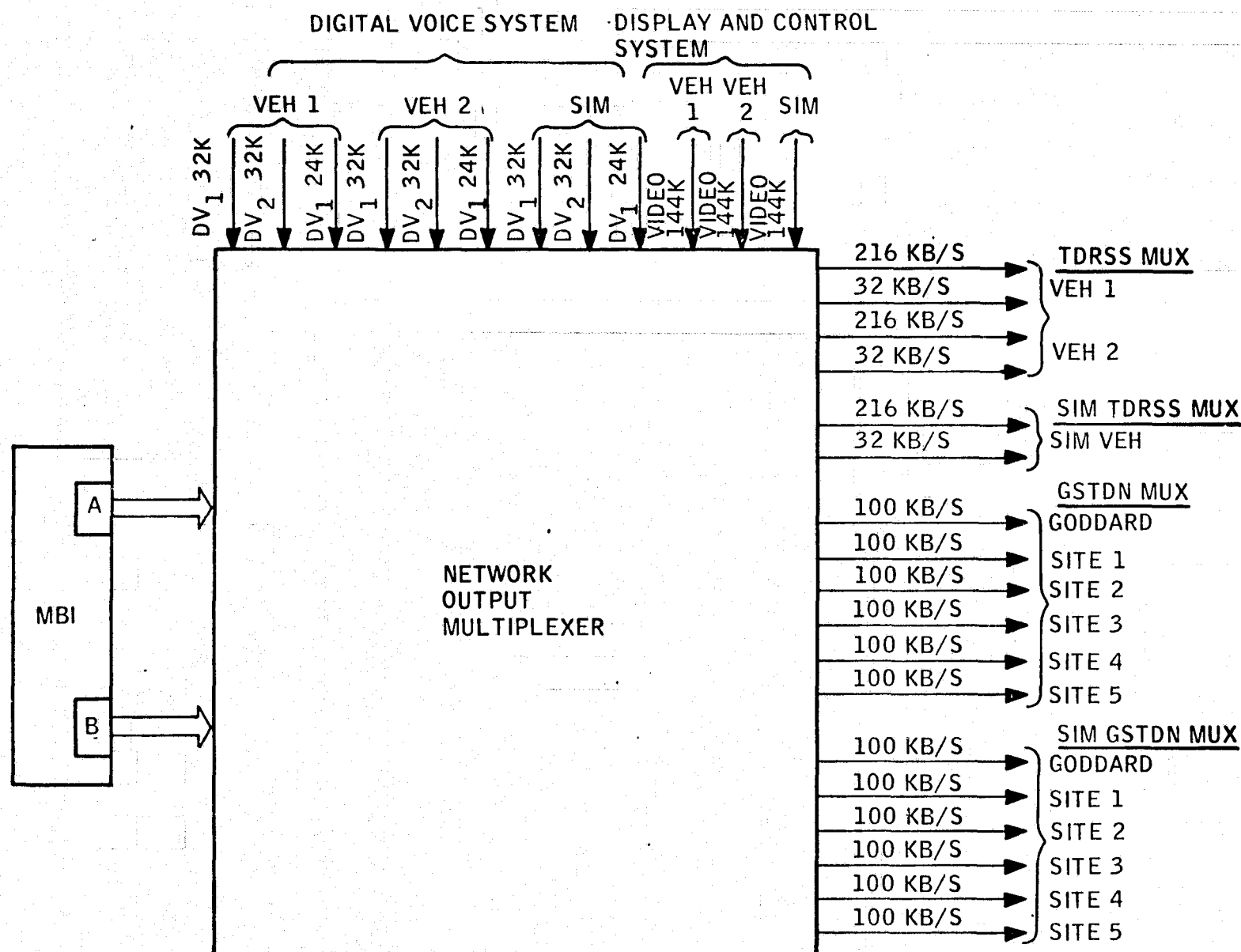


Figure 20 NOM System Interfaces

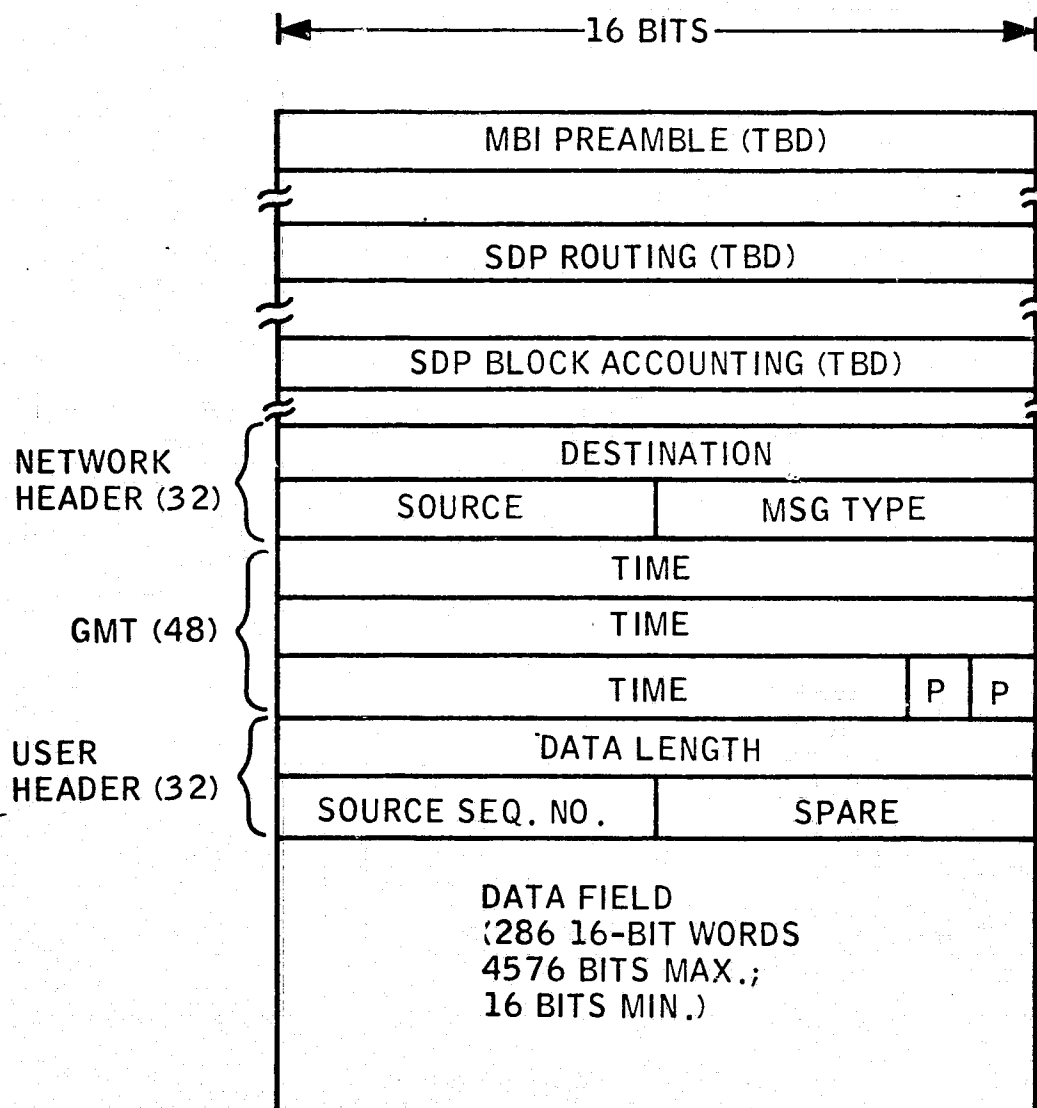
4.2.3.1.1 Interfaces for GSTDN

a. SDPC Interface

- (1) Operational Interface. The NOM shall receive data from the SDPC for output to the GSTDN. The SDPC output block will be similar to that shown in figure 21. The NOM shall provide a status message to the SDPC upon request by the SDPC or when certain error conditions or NOM configuration changes occur. Formats of status messages are TBD.
- (2) Physical Interface. The SDPC-to-NOM interface shall be via the MBI and shall provide redundant access capability to each of the MBI systems. The MBI-to-NOM interface shall provide 16-bit parallel data transfer at rates up to 9.6 Mb/s.
- (3) Electrical Interface. The MBI-to-NOM electrical interface characteristics are TBD.

b. GSTDN MUX Interface

- (1) Operational Interface. The NOM shall provide outputs to the GSTDN MUX in the NASCOM block format. The NOM shall message switch output blocks to six MUX ports (GSFC, plus five sites). Interfaces to individual MUX ports shall consist of serial data and clock signals at 100 kb/s supplied by the NOM.
- (2) Physical Interface. NOM output lines shall be routed through the WBD Switch or Digital Data Line Switch (OPS) to the GSTDN MUX.
- (3) Electrical Interface. (TBS)



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Figure 21 SDPC to NOM Data Block

4.2.3.1.1 Interfaces for GSTDN. (Continued)

c. Timing Interface

- (1) Operational Interface. The Timing Subsystem (TS) shall provide a 1 MHz square wave to the NOM for derivation of 100 kHz clock signals to the GSTDN MUX.
- (2) Physical Interface. The TS shall provide redundant 1 MHz signals on separate coaxial cables to the NOM.
- (3) Electrical Interface. (TBS)

4.2.3.1.2 Simulation of the NOM/GSTDN Function. The NOM shall provide the block data output from the SDPC to the Simulation GSTDN MUX. All simulation input and output interfaces shall have characteristics identical to the operational NOM/GSTDN function. The data path through the NOM for simulations shall be separate from the operational NOM/GSTDN data path to preclude degradation of the operational NOM/GSTDN throughput rate of 100 kb/s. Selection of the simulation data path shall be accomplished by assignment of unique SDP ROUTING identifiers (reference figure 21) to simulation ports.

4.2.3.2 TDRSS Uplink Formatting. The NOM shall provide time-division multiplexing of Orbiter uplink data transmitted via TDRSS. The NOM shall receive command and computer load data from the SDPC and interleave this data with digital voice data, and digital text and graphics data to build the Shuttle Orbiter uplink formats. The NOM shall generate all uplink formats required for TDRSS support of Shuttle Orbiters. The NOM shall maintain continuous uplinks containing digital voice, text and graphics, and command fill when commanding is not required.

4.2.3.2 TDRSS Uplink Formatting. (Continued)

The NOM shall provide TDRSS uplink formatters for one Orbiter and one simulation vehicle for OFT with a backup formatter available for redundancy. The NOM shall provide TDRSS formatters for two Orbiters and one simulation vehicle for OPS with a backup formatter for redundancy. NOM TDRSS formatters shall be manually assigned to operational and simulation vehicles. Routing of SDPC data to NOM TDRSS formatters shall be provided by an SDP ROUTING field in the data block, designating the vehicle for the command or computer load data.

4.2.3.2.1 Interfaces for TDRSS

a. SDPC Interface

- (1) Operational Interface. The NOM shall receive data from the SDPC for output to the TDRSS network. The SDPC output block shall be similar to figure 21. The NETWORK HEADER, GMT and USER HEADER fields shall not be required for TDRSS uplink formatting. The SDPC may insert FILL in these fields. The NOM shall provide a status message to the SDPC upon SDPC request or when certain error conditions or NOM configuration changes occur. Formats of status messages are TBD.
- (2) Physical Interface. The SDPC-to-NOM interface shall be via the MBI. The NOM-to-MBI interface shall provide redundant access capability to each of the MBI systems. The MBI-to-NOM interface shall provide 16-bit parallel data transfer at rates up to 9.6 Mb/s.
- (3) Electrical Interface. The MBI-to-NOM electrical interface characteristics are TBD.

4.2.3.2.1 Interfaces for TDRSS. (Continued)

b. TDRSS MUX Interface

- (1) Operational Interface. The NOM shall provide outputs to the TDRSS MUX in the Orbiter uplink formats defined by the *Shuttle OFT Data Format Control Book*. The NOM shall output high-bit rate (HBR) and low-bit rate (LBR) Orbiter uplink formats continuously. The NOM shall insert command fill when SDP commands are not available. Interfaces to individual TDRSS MUX ports shall consist of serial synchronous data and clock signals provided by the NOM.
- (2) Physical Interface. NOM output lines shall be routed through the WBD Switch or Digital Data Line Switch (OPS) to the TDRSS MUX.
- (3) Electrical Interface. (TBS)

c. Digital Voice Interface

- (1) Operational Interface. The NOM shall receive digital voice data in continuous serial streams from the DVS and shall time-division multiplex these inputs into the TDRSS Orbiter uplink formats. The DVS shall supply two 32-kb/s and one 24-kb/s digital voice input for each Orbiter supported. Each digital voice input to the NOM shall consist of continuous serial delta-modulated voice data and clock signals provided by the DVS. Data and clock rates shall be derived from an Atomic Frequency Standard (AFS) clock source.
- (2) Physical Interface. The DVS shall provide data and clock signals on coaxial cables to the NOM.

4.2.3.2.1 Interfaces for TDRSS. (Continued)

(3) Electrical Interface. (TBS)

d. Digital Video Interface

(1) Operational Interface. The NOM shall receive digital text and graphics data in a continuous serial format from the DCS and time-division multiplex the digital video inputs into the TDRSS Orbiter HBR uplink format. The DCS shall supply one 144-kb/s digital video input for each Orbiter supported. Each digital video input to the NOM shall consist of continuous serial data and clock signals provided by the DCS. Data and clock rates shall be derived from an AFS clock source.

(2) Physical Interface. The DCS shall provide data and clock signals on coaxial cables to the NOM.

(3) Electrical Interface. (TBS)

e. Timing Interface

(1) Operational Interface. The TS shall provide clock rate inputs to the NOM for derivation of TDRSS Orbiter uplink data rates. The NOM timing input rates shall be derived from an AFS clock source. The NOM shall require one or more square wave source rates from which rates of 216 kHz, 72 kHz, and 32 kHz may be derived.

(2) Physical Interface. The TS shall provide redundant clock signals on separate coaxial cables to the NOM.

(3) Electrical Interface. (TBS)

4.2.3.2.2 Simulation of the NOM/TDRSS Function. The NOM shall provide the time-division multiplexing function for SDP data, digital voice, and digital video data output to the simulation TDRSS MUX. All simulation I/O interfaces shall have characteristics identical to the operational NOM/TDRSS function. Selection of the simulation uplink formatter for SDP command and computer load outputs shall be accomplished by assignment of a unique SDP ROUTING identifier (reference figure 21).

4.2.4 Dump Data Processing Subsystem (DDPS). The DDPS shall include all functions necessary to correct dump idiosyncrasies and output dump data to the NIP.

Telemetry dump data shall be output to the DDP from the NCIC elements of the NIP. The NCIC shall perform the necessary acquisition and synchronization functions and return a digital data stream, accompanied with timing and control signals, to the DDP. The DDP shall perform the necessary ordering, reverse data correcting, and quality monitoring functions, and return the dump data to the NIP at a rate compatible with the TPC element of the NIP.

The configuration control functions of the DDP shall be activated and directed in accordance with command data received from the centralized MCC configuration control center. A manual mode of injecting test signals shall be available only in an offline maintenance mode.

4.2.4.1 Functional Requirements. The DDP Subsystem's input data rate shall be from a 224 kb/s to approximately 6.3 Mb/s burst with a dump data rate to real-time data rate ratio of up to 8:1 at a record data rate of 128 kb/s.

The NCIC elements of the NIP shall output dump telemetry data and voice in BDF in bursts of up to 6.3 Mb/s to the DDP.

4.2.4.1 Functional Requirements. (Continued)

- a. Chronological Ordering. The DDP shall output dump data in chronological order using Master Synchronization and Timing Unit (MSTU) GMT 1 or MSTU GMT 2 (selectable). The chronological ordering capability shall handle at least the quantity of data in one worst case dump (92.2×10^6 bytes). (A dump shall be defined as that data dumped to a site during a single acquisition.)
- b. Reversed Dump Correction. The Orbiter Communication System shall be designed so that data dumped from the maintenance recorder can be in data blocks of various orientation (e.g., forward and backward data blocks mixed in one dump). The DDP shall provide the capability to correct dump data received in the reverse mode to the forward mode.
- c. Table of Available Data. The DDP shall provide to flight controllers data content versus spacecraft time (MSTU GMT) and site ID to facilitate data selection within a dump for MCC dump playback to the NIP. The method of transfer and format of this information is TBD. In addition to the available data information, the DDP shall provide the capability to search and playback specific dump data segments (e.g., time of anomaly data) to be processed by the NIP.
- d. Quality Monitoring. The DDP shall monitor dump data quality by detecting A/G sync and reporting the number of sync losses versus the number of A/G frames for each dump received. The DDP shall monitor quality (A/G sync losses), format ID, and spacecraft time (MSTU GMT) on DDP input data, i.e., monitor as data is being received by the DDP.

4.2.4.1 Functional Requirements. (Continued)

- e. System Throughput. The DDP shall provide sufficient throughput capability to handle 21 hours (spacecraft time) of dump data received within a 24-hour period without creating a backlog. The DDP shall have a maximum data processing time (time from end of dump received to start of output) of 5 minutes.
- f. Output Rate. The DDP shall output dump data at a 1:1 forward rate (i.e., 128/192 kb/s) to the NIP and at accelerated forward rates compatible with the TPC for output to tape.
- g. Dump Range Tape Playback. The DDP shall provide the capability to input dump data from the Historical Recording Facility to facilitate playback of dump range tapes recorded at the STDN/TDRSS ground stations.
- h. Input/Output Overlap. The DDP shall provide inputs and outputs for two independent data streams. The DDP shall provide the capability to operate all inputs and all outputs simultaneously.
- i. Storage. The DDP shall provide the following storage per vehicle:
 - System internal storage capability with an access time of ≤ 5 minutes for the last 90 minutes (129.6 Mb/s) of dump data received at MCC
 - Access time of ≤ 15 minutes to dump data not in internal storage and not yet worked off to trends and plots

4.2.4.1 Functional Requirements. (Continued)

- Access time of ≤ 1 hour for playback of mission dump data which has been worked off to trends and plots.

4.2.4.2 Interfaces. TBS.

4.2.5 Voice Communications Subsystem (VCS). The VCS shall consist of the following elements.

- a. Console Communication Subsystem (CCS). The CCS shall provide the following:
 - Conferencing capability among various locations within the MCC
 - Talk and/or monitor capability on conference circuits
 - Access for certain specific conference circuits to external communications facilities
 - Private communications capability among the various locations within the MCC
 - Private communications capability between the locations within the MCC and the NASCOM voice network
 - Access by certain specific positions to the PA System.
- b. Communication Line Switch (CLS). The CLS shall consist of a 2-position manual, 4-wire switchboard and associated equipment necessary to interconnect on a direct (2-party) or conferencing (multiparty) basis. The following types of communications circuits shall be used.

4.2.5 Voice Communications Subsystem (VCS). (Continued)

- Single party voice circuits within MCC
 - Conference circuits within MCC
 - Longline circuits from NASCOM stations
 - Longline circuits direct from NASA sites (KSC, etc.)
 - Local JSC circuits.
- c. Public Address (PA) Equipment. The PA equipment shall provide the distribution of information and paging messages to separate and independently accessible zones within MCC.
- d. Air-to-Ground (A/G) Equipment. The A/G equipment shall provide capability for selected CCS users to communicate directly with the onboard crew, either via GSTDN or through the DVS and TDRSS.
- e. Digital Voice Subsystem (DVS). The DVS equipment shall provide the capability to interface the analog inhouse A/G loops with the TDRSS direct digital uplink/downlink channels.
- f. Central Power Equipment. The Central Power equipment shall provide 25 V ac, -24 V dc and -48 V dc operating and supervision power to the MCC VCS.

4.2.5.1 Console Communications Subsystem (CCS). Voice communications shall be handled over numerous loops terminated on station keysets and jack stations located at MCC operating positions (see figure 22). The loops shall be independent, and each circuit shall be capable of servicing a maximum of 180 stations. The maximum number of stations can be increased by the addition of special extension loop amplifiers.

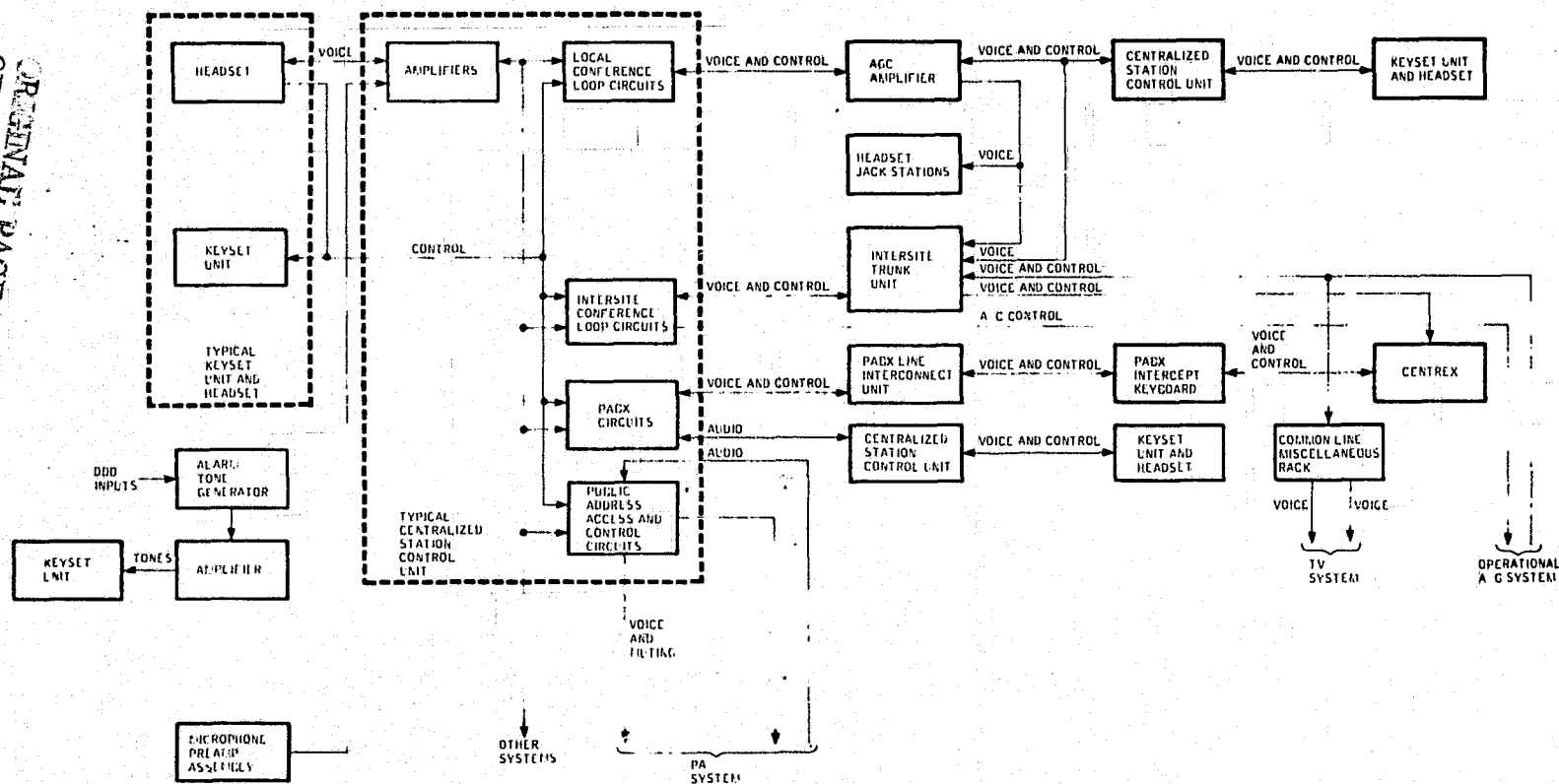


Figure 22 CCS Block Diagram

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4.2.5.1.1 Voice Loops. There shall be five types of voice circuits as defined in the following paragraphs.

- a. Local Conference Loops. These loops shall comprise 4-wire conference circuits providing 2-way communications and monitoring capability for all stations on the loop. Other CCS loops cannot be connected to the conference loop, nor shall this loop require signalling. There shall be a total of 204 local conference loops.
- b. Intersite Conference Loops. These loops are similar to the local conference loops, but shall have the added capabilities to permit 2-way signalling between the MCC and remote location, and interconnection to a similar loop or to a remote station by landline or common-carrier interface. There shall be a total of 200 intersite conference loops.
- c. PA Loop. This loop shall be a 2-wire, talk-only circuit providing access to the PA speaker system. There shall be a maximum of 16 PA loops.
- d. Centrex Loops. These loops shall provide access to the commercial telephone network. Lamp signalling and optional ringing shall be provided for incoming calls, and specified stations shall have dial facilities for outgoing calls. There shall be a total of 112 Centrex loops.
- e. Point-to-Point Loops. Local point-to-point and intersite point-to-point loops are similar to the local conference and intersite conference loops, respectively; however, both shall be wired for manual or automatic signalling.

4.2.5.1.2 CCS Stations. CCS stations shall be defined as keyset stations, jack stations, and remote stations. They are defined in the following paragraphs.

4.2.5.1.2 CCS Stations. (Continued)

a. Keyset Stations

- (1) Horizontal Console-Mounted. The horizontal console-mounted keyset shall be equipped to accommodate a maximum of 48 talk-listen (T/L), talk/listen-monitor (T/L-M), monitor, and transfer keys; 5 or 6 common keys (hold, ring, release, buzzer, multiaccess, and mode select on some), a dial device, and a volume control. Not all positions, however, shall accommodate T/L-M.
- (2) Vertical Console-Mounted. The vertical console-mounted keyset shall have capabilities identical to those of the horizontal-mounted keyset.
- (3) Rack-Mounted. The rack-mounted keyset shall be equipped to accommodate a maximum of 48 keys (T/L, T/L-M, monitor, and transfer), 5 or 6 common control keys, a dial device, a volume control, and 2 headset jacks. Not all positions, however, will accommodate T/L-M.
- (4) Desk Top-Mounted. The desk top keyset shall be equipped to accommodate 48 keys or 36 keys (T/L, T/L-M, monitor, and transfer), 5 or 6 common control keys, a volume control, and 2 headset jacks.
- (5) Desk- or Pedestal-Mounted. The desk or pedestal keyset shall be equipped to accommodate 10 keys (T/L, monitor, and transfer), 2 control keys, a buzzer, a volume control, and 2 headset jacks.

4.2.5.1.2 CCS Stations. (Continued)

b. Jack Stations

- (1) Single-Loop. Single-loop jack stations shall be wired for T/L or monitor on one loop. Approximately 240 single-loop jack stations shall be provided.
- (2) Three-Loop. Three-loop jack stations shall be wired for T/L or monitor on any one of three selectable loops. Approximately 140 three-loop jack stations shall be provided.

- c. Remote Station. The remote station shall be designed to work at a remote location with the MCC VCS. The station shall be equipped with 10 or 36 keys providing T/L, T/L-M, or monitor access, and 6 common keys. The remote station shall be self-contained with power and necessary encoding and decoding logic to work on a MODEM or frequency-shift keyed (FSK) circuit to MCC. An interface unit shall be provided at MCC on the CCS to encode/decode signals to and from the remote station.

4.2.5.1.3 Interfaces

- a. Operational Interface. Access to CCS voice loops shall be through pushbutton indicator (PBI) keys and jacks. All transmitters shall be push-to-talk, and speakers associated with keysets shall be muted while the transmitters are keyed. Talk circuits shall be electrically interlocked, thus permitting access to one single loop at a time. Keysets with multiaccess capability, however, shall permit access of up to three talk circuits simultaneously (except the PABX line, which shall release all talk circuits when selected). Any number of monitor loops appearing on the keyset may be simultaneously selected. Lamp supervision (wink, flash, and flutter) shall indicate the status of PBI keyset

4.2.5.1.3 Interfaces. (Continued)

operations. Audible signals shall provide for station calling. Operational configurations shall be handled in the Centralized Station Control Subsystem (capable of accommodating a total of 351 keysets) by plug-in modules and cross-connecting on the CDF. Additional reconfigurations or circuit assignments may be handled by jacks and cut keys on the Test and Patch Bay Facility.

- b. Physical Interface. CCS keyset stations, jack stations, and deskset stations shall be located throughout the MCC with a limited number of keysets located in other JSC buildings that support mission operations. All CCS equipment on the second and third floors of the MCC shall be cabled to Intermediate Distribution Frames (IDF) on the respective floors, and from there connected by tie cable to the CDF. Terminal equipment consisting of interrupter and transfer circuits, local conference loop circuits, intersite conference loop circuits, PABX circuits, control and access circuits, PA access and control circuits, selective ring circuits, single- and three-jack access circuits, patch and switch circuits, and critical alarm circuits shall be located in the centralized station equipment. Operating and control circuits for this equipment shall be cabled to the CDF. For PABX access, the Telco shall furnish a tie cable to the CDF permitting an interface to the commercial telephone network.
- c. Electrical Interface. Local and intersite conference loop amplifiers shall accept signals with up to 20 dB input variation, and deliver a signal with a maximum ± 3 dB variation when loaded with up to 180 circuits. PABX dialing shall provide pulse rates from 9.5 to 10.5 pulses per second, with a 58 to 64 percent break. The MCC shall accept 90-V, 20-Hz signalling from the commercial telephone network. Talk

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4.2.5.1.3 Interfaces. (Continued)

voltage for all voice communications shall be 48 V dc. Interrupter and transfer circuits shall apply flash, flutter, and wink lamp supervision to all CCS PBI's. The centralized station control units shall provide switching and signalling circuits (25 V ac) for each PBI, and send and receive voice amplifiers for headset common circuits.

4.2.5.2 Communications Line Switch (CLS). The CLS shall be a manually-controlled switchboard used to configure external lines to internal loops (intersite trunks), or to conference a number of lines and/or loops together. All operations shall be performed from either of two redundant operating consoles. These consoles shall be standard MCC consoles with two operator positions. The positions shall be wired with multiple lines to provide independent line access from either position to the common link equipment. Control and supervision of the lines shall be provided at each position by flush-mounted illuminated PBI keys. Additional keys at each position shall provide control of conference connections and common functions. The console equipment shall be limited to keys and to any switches which are an integral part of the key assembly. All relay circuitry, common equipment, etc. shall be mounted in centrally-located common equipment racks.

4.2.5.2.1 Switching and Conferencing Equipment

- a. Switching Capability. The switching capability of the CLS shall provide for connection of the following:

- (1) Any 4-wire line to another 4-wire line, or any line to a 10-party conference circuit.

4.2.5.2.1 Switching and Conferencing Equipment. (Continued)

- (2) Group switching to allow the connection of 10-party conference groups together for a 30-party conference.

b. Conference Connections. Conference capability shall be as follows:

- (1) Lines may be added or dropped from an established conference without affecting other lines on the conference circuit.
- (2) Identification shall be provided at the operators console of all lines associated with any one conference.

c. Signalling and Supervision

- (1) Signalling. Incoming signals shall activate lamp supervision and audible alarms at the console operators position. Ring-off shall be necessary, and the re-ring signal activates supervision as required.
- (2) Supervision. Line and link supervision shall be provided in the form of multicolor key lamp indications.

d. Functional Description

- (1) Line Capacity. The CLS shall have the capability to control and switch 230 4-wire circuits, with the capability to expand to 300 lines.
- (2) Link Capacity. A link shall be defined as the internal CLS circuitry which interconnects a line to any other line or lines. The CLS shall have the capability to control and switch all lines to configure any combination of 2-party or multiparty conferences, with full trunk capability.

4.2.5.2.1 Switching and Conferencing Equipment. (Continued)

- (3) Line Switching Matrix. A switching matrix shall be provided to perform switching functions as required. The number of 4-wire lines accommodated shall be 230, and the matrix design shall permit expansion without disruption of the existing capability. Links shall be switched to provide audio connections between 150 2-party lines, 10 10-party conference circuit links, or combinations of the two types.
- (4) Signal-Through Circuit. A provision shall exist for connecting the signalling circuits through additional connections in the 2-party link portion of the matrix so that dc signalling voltage received from either line causes dc signalling voltage to be sent to the other line. Either operator may establish the connection by pressing the SIGNAL-THROUGH key immediately following normal 2-line connection and before the operator RELEASE key is pressed.
- (5) Two-Party Link. The 2-party link, when used as part of a line-to-line circuit, shall have the capability to allow the line-to-line circuit to equal or exceed the requirements specified in paragraph 4.2.1.2.
- (6) Automatic Link Selector. Operator access to a line not already connected to a link shall cause the Automatic Link Selector to select the next idle link and provide control to devices that connect the accessed line to the selected link. In addition, the Automatic Link Selector shall precondition connection of the link to additional idle lines. The Automatic Link Selector shall not function when lines are being connected to conference circuits.

4.2.5.2.2 Transmission Requirements

- a. Transmission Level. The TTL at the CLS 4-wire interface shall be 0 dBm.
- b. Crosstalk Level. Crosstalk shall not exceed 50 dBm, measured on any unloaded receive line with all other lines test tone loaded.
- c. Frequency Response. The frequency response of any normal voice path through the CLS shall be such that the net level change for any signal between 300 and 3000 Hz is within 3 dB of the level for a 1000-Hz signal.
- d. Line Termination. Idle line terminations shall be provided for all lines.
- e. Return Loss. Return loss for all lines under normal conditions of operation at any frequency of interest shall not be less than 40 dB.
- f. Longitudinal Balance. Longitudinal balance across lines terminated through a link shall equal or exceed 40 dB when measured according to *EIA Standard RS-210*.
- g. Distortion. Distortion shall not exceed 5 percent.
- h. Line Isolation Requirements. With three or more lines connected through a common link circuit, the isolation between lines shall be such that a short on either pair of lines does not cause the nominal TTL on either pair of remaining lines to change by more than 3 dB, providing the short occurs on the house side of the CLS 4-wire interface.
- i. Impedance Characteristics. The terminating impedance shall be 600 ohms ± 5 percent.

4.2.5.2.3 Interfaces

a. CCTCF (Audio) Interface

- (1) Operational Interface. Interface shall exist between the CLS and the CCTCF at the patch and test bay.
- (2) Physical Interface. The point of physical interface shall be the distribution frame.
- (3) Electrical Interface. TTL's measured at the physical interface shall nominally be 0 dBm send and receive, adjustable ± 3 dB; operational (speech power) shall be -8 volume units (VU's); impedance shall be 600 ohms, balanced to ground. Signalling shall be -48 V, referred to ground, and introduced on the circuit at the end originating the ring. Bad line supervision shall consist of -48 V, referred to ground, applied through the CLS bad line lamp to CCTCF.

b. CCS (Audio) Interface

- (1) Operational Interface. Interface shall exist between CLS and CCS at the patch and test bays.
- (2) Physical Interface. The point of physical interface shall be the CDF.

c. Central Power Interface

- (1) Operational Interface. Interface for 24 and 48 V dc for CLS power shall exist at the CLS power bay. Lamp power (24 V dc) fusing shall also be provided on this bay.

4.2.5.2.3 Interfaces. (Continued)

- (2) Physical Interface. The point of physical interface shall be the main power distribution fuses in 24 and 48 V dc distribution bays.

4.2.5.3 Public Address Equipment

4.2.5.3.1 Functional Description. The PA equipment shall provide coverage of the Bldg. 30 MOW to permit announcements to be broadcast into all rooms. To permit announcements of interest to certain operational areas without disruption to other personnel, the MCC MOW shall be divided for coverage into common-interest zones. All loudspeakers in each zone shall be ganged to a power amplifier for that zone; by selectively accessing an amplifier or group of amplifiers, a single zone or group of zones may be selected for announcements. Provision shall be made for announcements by microphones located within each zone through use of a separate group of speakers at the microphone location; these speakers shall be muted during an announcement to prevent acoustical feedback. Figure 23 is a block diagram of the PA equipment for one zone.

4.2.5.3.2 Interfaces

- a. Operational Interface. The PA systems shall accept inputs from both the CCS system (one input per zone up to 12 zones from any 48 PBI CCS keyset) and microphone direct input.
- b. Electrical Interface. Average speech output level from the CCS operating positions into the PA system shall be -8 dBm into a nominal 600-ohm load at 1000 Hz. Speech channel bandpass into the amplifiers shall be from 300 Hz to 3000 Hz from the CCS. Amplifiers shall be 70.7 V rms constant level, 35, 40, and 100 watts, with the higher power amplifiers used in the high density zones.

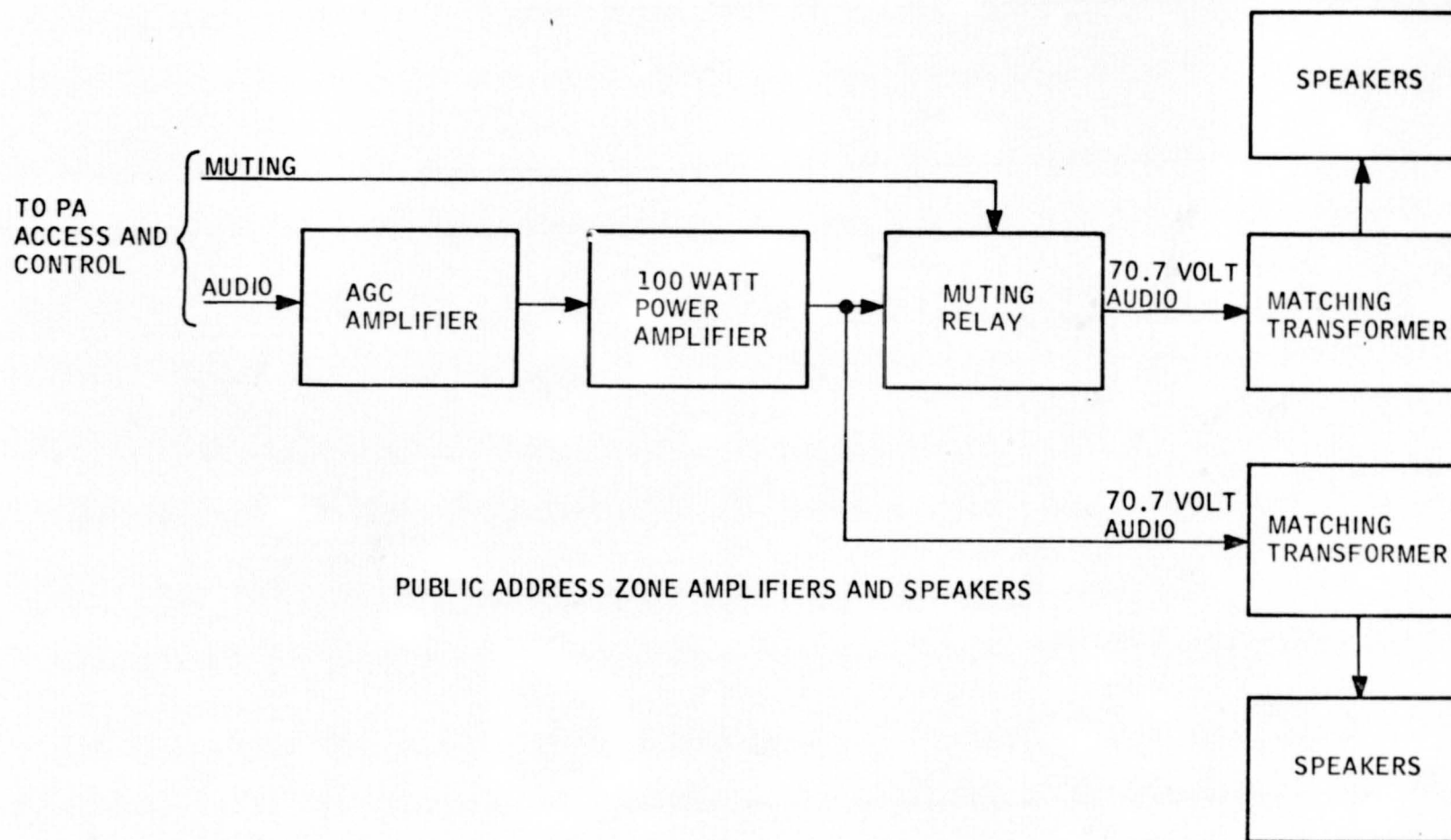


Figure 23 Public Address Circuits Block Diagram

4.2.5.4 Air/Ground Equipment

4.2.5.4.1 Functional Description. The A/G equipment shall provide the capability for personnel at selected CCS operating positions to communicate with the onboard Orbiter crew. The equipment shall consist of standard CCS intersite conference loops dedicated to each A/G circuit, tone keying equipment to interface analog network and DVS voice channels, and a configuration switch. The block diagram of one A/G channel is shown in figure 24. Two A/G circuits per vehicle for three vehicles (two operational and one simulation) shall be provided.

4.2.5.4.2 Interfaces. The A/G equipment shall provide one interface to the GSTDN longlines and another interface to the DVS.

a. GSTDN Interface

- (1) Operational Interface. The GSTDN analog interface shall be via the A/G configuration switch to the GSTDN A/G longlines.
- (2) Electrical Interface. TTL's measured at the interface shall nominally be 0 dBm send and receive, ± 3 dB; operation (speech power) shall be -8 VU; impedance shall be 600 ohms, balanced to ground. Keying shall be by 250 ms tone burst at a -8 VU level; a tone of 2525 Hz shall be used for keying, and a tone of 2475 Hz for unkeying. The keying tones shall be superimposed on the transmit voice at the beginning and end of transmission and generated by operation on the console keysets push-to-talk switch.

b. DVS Interface

- (1) Operational Interface. The DVS voice interface shall be an analog interface via the A/G configuration switch to the voice channels of the DVS, e.g., the outputs of the delta demodulators and the inputs to the delta modulators.

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Figure 24 A/G Block Diagram

4.2.5.4.2 Interfaces. (Continued)

- (2) Electrical Interface. TTL's measured at the interface shall nominally be 0 dBm send and receive, ± 3 db; operation (speech power) shall be -8 VU; impedance shall be 600 ohms, balanced to ground. Keying shall be by a dry contact closure generated by operation of the console keyset push-to-talk switch.

4.2.5.4.3 Configuration Switching and Control Console. TBS.

4.2.5.5 Digital Voice System (DVS)

4.2.5.5.1 Functional Description. The DVS shall provide the capability to interface analog A/G loops with the digital uplink/downlink data streams received from the Orbiter through the TDRSS. It shall include the delta modulators, the delta demodulators, the voice strippers for extracting incoming voice from the telemetry stream, and the configuration switching and control console. Two channels per vehicle shall be provided for three vehicles (two operational and one simulation).

4.2.5.5.2 Performance Requirements. TBS.

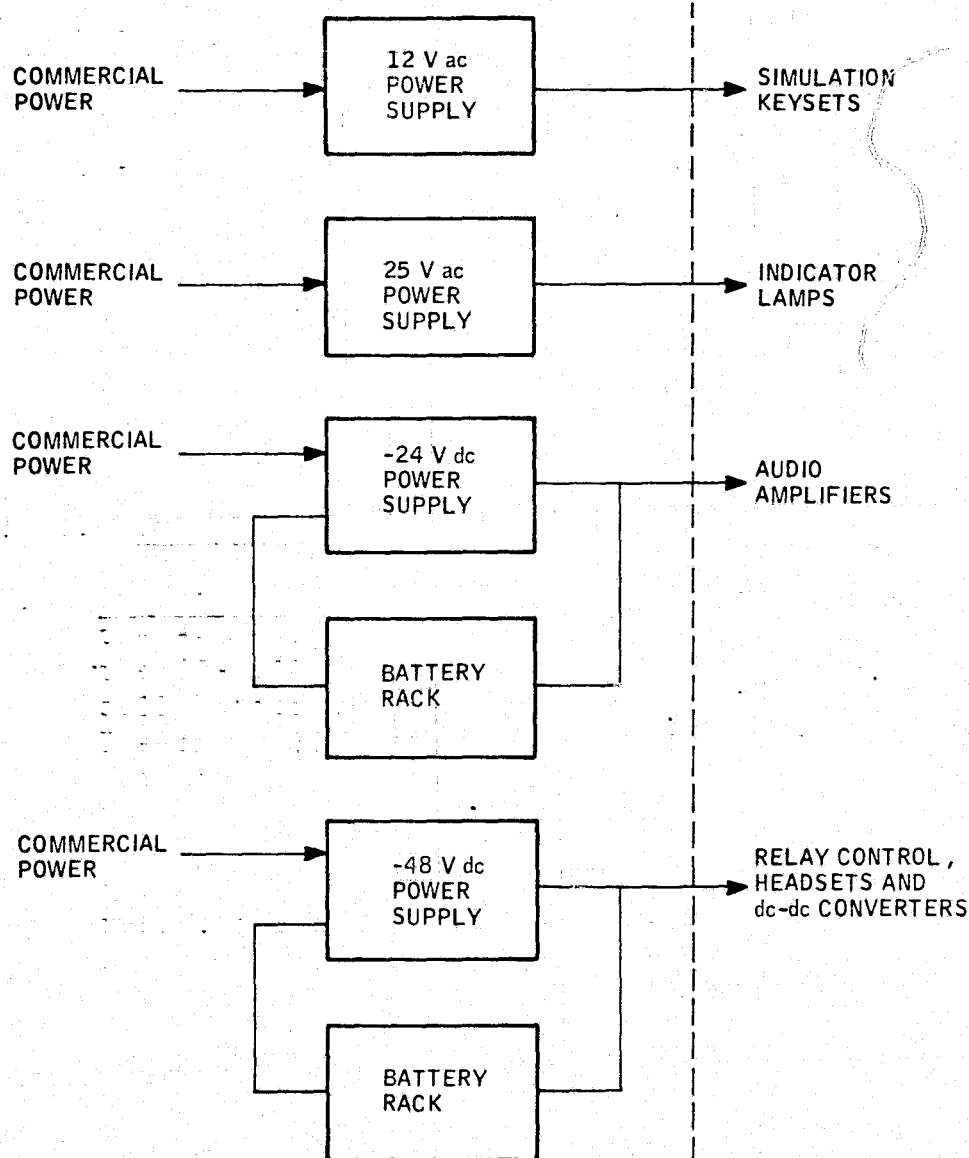
4.2.5.5.3 Interfaces. TBS.

4.2.5.6 Central Power System

4.2.5.6.1 Functional Description. A central power supply shall provide operating and supervision power to all MCC voice communications equipment. This supply shall consist of a central dc power supply, dc-to-dc converters, and an ac lamp supply. The dc power supply shall consist of both 24- and 48-V storage batteries, battery chargers, power boards, and power distribution panels. The 24- and 48-V power supplies shall be connected to provide a negative potential with respect to their common return line. The ac lamp supply shall consist of a 25-V ac supply for signalling and supervisory lamps, and a 12-V ac supply for supervisory lamps. The dc-to-dc converters shall provide +12 V dc, -12 V dc, -26 V dc, and -24 V dc, all from the -48 V dc battery supply. A block diagram of the central power system is shown in figure 25.

4.2.5.6.2 Interfaces

- a. Operational Interface. During normal operations, the -48 V dc battery chargers shall trickle-charge the 23-cell battery, trickle-charge a 3-cell end cell battery, and supply power to the equipment. The end cell battery shall be connected in series with the load when battery voltage drops below -46 V dc. As recharging raises the battery voltage above -53 V dc, the end cell shall be disconnected, and both the 23-cell battery and end cell battery shall resume trickle-charge. The -24 V dc battery chargers shall trickle-charge the 12-cell batteries and supply power to the equipment. The recharge scheme is similar to that of the -48 V dc system, except that no end cells shall be used. Battery capacity shall provide 6 hours of operation without commercial power.
- b. Physical Interface. Two 24-volt and three 48-volt rack-mounted battery charger/rectifiers connected in parallel for maximum current shall supply dc power. The 12-cell and a 23-cell battery shall provide -24 V and -48 V emergency power when commercial technical power fails.



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Figure 25 Central Power System Block Diagram

4.2.5.6.2 Interfaces. (Continued)

- (1) The 24 V dc power supply shall connect to a distribution fuse panel which shall supply -24 V dc fused power to the common equipment racks and to external areas requiring central power. Additionally, -26 V dc power shall be supplied from the power distribution racks by voltage reducers (batt-taps) to a separate dc lamp battery fuse distribution panel in the CLS power panel. Additional voltage reducers shall step down -48 V dc to -26 V dc, -12 V dc, and +12 V dc, all for exclusive use by the A/G System; dc power shall be connected to fuse panels and routed to the A/G equipment.
 - (2) The -48 V dc power supply shall connect to a distribution fuse panel which shall supply -48 V dc fused power to external areas requiring power.
 - (3) The ac power shall be supplied from rack-mounted 115 V ac stepdown transformers and rack-mounted distribution panels. Both 12 V ac and 25 V ac power shall be connected from terminal strips on the power supplies to the CDF, where it shall be cross-connected to the IDF's, and then to the CCS stations.
- c. Electrical Interface. Single-phase 115 V ac and 3-phase 208 V ac technical power shall be supplied from the commercial source to power panels, where it is distributed to equipment systems and convenience outlets in the various areas. The two 100-amp, -24 V dc charger/rectifiers and the three 100-amp, -48 V dc charger/rectifiers shall be designed to handle peak loads of approximately 100 amps and 200 amps, respectively. The -24 V dc and -48 V dc distribution panels shall have a current capacity

4.2.5.6.2 Interfaces. (Continued)

of 400 amps. The -26 V dc power supplies shall have a rated capacity of 15 amps, and the +12 V dc and -12 V dc power supplies shall have a rated capacity of 10 amps. The 25 V ac power supply shall have a rated peak load capacity of 1020 amps, and the 12 V ac power supply shall have a rated peak load capacity of 20 amps.

4.2.6 Consolidated Communications Recording Facility (CCRF).
The CCRF shall provide recording, playback, and archival facilities necessary to accomplish the following functions:

- Record all data entering and leaving the MCC for historical purposes
- Play back previously recorded historical data and site-provided tapes for post-occurrence analysis.
- Play back checkout and test tapes for testing and configuration verification purposes
- Record voice conversations on specific voice loops and at specific operating positions for historical purposes and also for quick retrieval
- Play back previously recorded voice conversations for post-occurrence analysis
- Provide multiple duplicates of selected voice tapes
- Provide GMT timing on an additional track on all recorders.

4.2.6.1 Data Recording. Data recording shall be accomplished by recording WBD on parallel multitrack recorders and recording HSD on serial multitrack recorders. Details of each are TBS.

4.2.6.2 Voice Recording. Voice recording shall be designed and equipped to provide the following:

- A post-mission record of conversations which take place on selected loops or from selected positions of the CCS
- Equipment capable of reproducing any portion of this record during the mission
- Equipment to sufficiently delay release of A/G conversations to news media to allow deletion of portions of the text
- Equipment capable of producing multiple copies of selected recordings at a commercial standard speed
- Console equipment for remote control of recorders.

4.2.6.2.1 Voice Historical Recording Equipment. This equipment shall consist of multichannel tape recorders to provide historical records of conversations which take place on preselected voice circuits of the MCC CCSS. The equipment shall be designed so that addition of a recorder channel to any voice circuits does not deteriorate the performance of that circuit's voice performance.

Two historical recorders shall be provided to record 28 channels on each recorder at a speed of 15/16 inches per second (IPS). These recorders shall have redundant power supplies and tape transports with automatic switchover between transports. GMT timing shall be included on a separate track. Inputs to these recorders shall be routed through normal-through jacks of the voice patch and monitor cabinet.

4.2.6.2.2 Voice Historical Playback Consoles. TBS.

4.2.6.2.3 Tape Copy Recorders. Eight 2-channel recorder/reproducers shall be provided for the direct record and playback of selected voice circuits, or for record and playback of the historical playback consoles. The tape copy recorders shall be as follows:

- Four recorder/reproducers capable of 7-1/2 and 15 IPS speeds
- Two recorder/reproducers capable of 7-1/2 and 3-3/4 IPS speeds
- Two recorder/reproducers capable of 3-3/4 and 1-7/8 IPS speeds

Record and playback channels for each machine shall be terminated in jacks on the voice patch and monitor bay to allow any voice circuit appearing on the patch field to be patched to any of the eight recorders. The above recorders shall be provided with on-off remote control capability, controlled from the Historical and WBD Recording Control Consoles. One channel shall be used for voice, and the other channel shall provide GMT timing.

4.2.6.2.4 Delay Loop Recorders. Two delay loop recorders shall be provided to delay transmission of a conversation on a selected voice circuit, or on a selected playback from the tape copy recorder. The delay time capability of each recorder shall be 5 or 15 seconds at low speed and 2.5 or 7.5 seconds at high speed.

4.2.6.2.5 Patching Facilities. A patching and monitoring facility shall be provided with the following jack appearances:

a. Recording Equipment

- Recorder inputs - 88
- Input monitors - 88
- Reproduce outputs - 88.

4.2.6.2.5 Patching Facilities. (Continued)

b. Loops and Miscellaneous Circuits

- CCS tie lines - 60
- CCTCF patch tie lines - 4
- Monitor amplifier inputs - 4
- Multiple recording circuit with 8 outputs - 1
- Historical playback access to CCS patch and test bay - 1
- Tape copy playback access to CCS patch and test bay - 1
- CCS loop mixing circuit inputs and outputs - 2.

c. Historical Playbacks. TBS.

d. Copy Equipment

- Recorder inputs - 16
- Recorder input monitors - 16
- Recorder outputs - 16
- Recorder output monitors - 16.

e. Delay Loop Recorders

- Delay loop inputs - 2
- Delay loop outputs - 2
- Voice operated relay (VOX) inputs - 2.

f. Timing System. GMT (TBD).

4.2.6.2.6 Miscellaneous Equipment. The following miscellaneous equipment shall be provided for support of the Historical Recording Subsystem.

- a. Timing Distribution Units. Two timing distribution units shall be provided to provide proper levels and impedances to distribute IRIG-B time code to the various recorders of the facility.
- b. Automatic Gain Control (AGC). A jack-ended AGC amplifier shall be provided to allow AGC amplification to be patched into any of the voice circuits appearing on the voice patch.
- c. Bulk Tape Eraser. A bulk degausser (eraser) shall be provided for erasing entire reels of tape. This equipment shall be capable of accepting reels up to 10-1/2 inches in diameter.

4.2.6.3 CCRF Control Consoles. TBS.

4.2.7 OFT/OPS Transition. TBS.

4.3 Data Computation Complex (DCC). The DCC shall provide computational, peripheral, and switching capability which will support the requirements derived from the *OFT Level A Requirements for the Shuttle Ground Data System (SGDS)*. Other applications (e.g., SDL, LACIE, ALSEP) shall also be supported by the DCC.

The DCC shall be composed of the Multibus Interface (MBI), Shuttle Data Processing Complex (SDPC), 360/75 Computer Complex, UNIVAC 494 Computer Complex, and the DCC-to-MCC Systems Configuration and Switching Equipment.

4.3.1 Multibus Capability. The MBI is an interface device that shall allow, at a minimum, 11 computers (8 TPC's and 5 SDPC's) to be interconnected in nearly any manner. Each computer shall have the capability to both receive and transmit data simultaneously, and to transmit data to one or two devices simultaneously. However, a computer shall not simultaneously receive data from multiple devices. The data transfers shall take place on five full-duplex buses at a rate of 500,000 bytes (8 bits/byte) per second. The MBI hardware can be divided into three different functional sections:

- Adapter and Bus
- Configurator and Controller (CC)
- Self-Tester and Maintenance Panel.

All of the hardware shall be redundant making the MBI an entirely redundant system.

4.3.1.1 Adapter and Bus. A unique adapter shall be made for each kind of device connected to the MBI. At a minimum there shall be two unique adapter designs, one for the TPC and one for the SDPC. If any more devices are added, they too shall require a unique adapter.

4.3.1.1 Adapter and Bus. (Continued)

- a. Level Conversion. The adapter shall convert computer voltage levels to TTL levels and TTL levels to computer levels.
- b. Word Conversion. The adapter shall convert the computer word to an 8-bit word for transmission over the bus.
- c. Bus Transmission Rate. The maximum transmission rate shall be 500K bytes per second.
- d. Error Detection. The adapter shall attach four bits of Hamming code to each word transmitted over the bus. The Hamming code is an error detection and correction code which can detect and correct one error, and can detect the presence of two or more errors.
- e. Number of Buses. There will be five full-duplex buses (or 10 half-duplex buses).

4.3.1.1.1 Interfaces

- a. Adapter-to-Adapter Interface. A half-duplex bus shall consist of the following lines:

<u>Line Name</u>	<u>No. of Lines</u>	<u>Function</u>
Bit lines	8	Bits of actual message (2^0-2^7)
Error lines	4	Hamming code (2^0-2^3)
Control	4	Control lines [ready to transmit (RTT), ready to receive (RTR), shift]
Total	16	

4.3.1.1.1 Interface. (Continued)

b. Computer-and-Adapter Interface

- (1) When the computer is transmitting a message the following lines shall be required:

<u>Line Name</u>	<u>No. of Lines</u>	<u>Function</u>
Data Field	TBD	Data from computer
RTT	1	Computer wants to transmit a message
RTR	1	Adapter ready to receive message
TBD	XX	Any more required

- (2) When a computer is to receive a message, the following lines shall be required.

<u>Line Name</u>	<u>No. of Lines</u>	<u>Function</u>
Data Field	8	Eight bits directly from the bus
Error	2	Number of errors detected
RTT	1	Message to be sent through adapter
RTR	1	Computer ready to receive message through adapter
TBD	XX	Any more required

4.3.1.1.1 Interface. (Continued)

- c. Adapter and CC Interface. The computer shall communicate with the CC through the adapter. The CC shall scan the adapters with the adapter select lines, and monitor the auxiliary control lines to determine the status of the adapter and whether adapter wants to transmit data to the CC. If the CC wants to transmit to the adapter, it shall do so over the same lines with a separate line indicating that the adapter is to receive.

The types of messages to be sent from the adapter to the CC shall be origination code, destination code, priority code, number of words to be transmitted, and status of transmitter and receiver.

The types of messages to be sent from the CC to adapter shall be adapter select, bus select, CC transmitting, configure, status of destination adapter, and transmit status to host computer.

4.3.1.1.2 Local Control. The local control on each adapter shall take data from either the computer or CC and configure itself accordingly to handle transmission or reception of a message to another adapter(s). The local control on each adapter shall take the external control lines coming into it and reduce them to the four necessary control lines for bus operation. The local control shall take the four control lines coming in on the bus and control lines from host computer and CC and manipulate them so as to give the CC or host computer the status of that adapter.

4.3.1.2 Configurator and Controller (CC). The CC shall assign buses to adapters so that they may communicate with each other and shall also configure the adapters to either transmit or receive data on a specific bus.

4.3.1.2 Configurator and Controller (CC). (Continued)

- a. Bus Assignment. The CC shall assign buses on a priority basis. If a computer is tied up with another computer, other computers that want to communicate with it shall be queued up in order of their priorities. The priority shall be sent to the CC, along with other messages designating what the bus configuration should be.
- b. Communication with Adapters. The CC shall be capable of communicating with each separate adapter. It shall configure them from the message received through the adapter from the transmitting computer and initiate transmission.
- c. Mission Bus Assignment. One or more buses can be taken out of the randomly assigned bus pool and dedicated to a particular set of computers. This can be accomplished through the CC from the maintenance panel.
- d. Communication Status. If the CC is unable to set up a path to a computer in a specific amount of time, it shall inform the originating device that a path is not available and to take what ever action is appropriate. The CC shall also light a lamp on the maintenance panel to inform operators that either all buses are busy or that a particular adapter is tied up.

4.3.1.3 Self-Tester and Maintenance Panel. The self-tester shall be capable of simulating all computers. It shall indicate on the maintenance panel or other appropriate device what test is being run and the tests status.

4.3.1.3 Self-Tester and Maintenance Panel. (Continued)

- a. Device Simulation. Each computer shall have its output lines to the adapter or'ed with the self-tester's output lines. The self-tester shall be capable of generating all the necessary codes to simulate priority destination, origination and word length, as well as some predetermined bit patterns to be sent over the bus.
- b. Error Detection. When running the MBI in self-test, the data at various points within the adapter can be compared with what is being sent. This shall enable an operator to pinpoint specific malfunction in an adapter if the error is being generated there.
- c. Error Handling. If an error is discovered while running a test, it shall stop at that particular step in the test. The test can then either be re-started at that point, or run through the particular failure respectively. On the maintenance panel, the location where the error occurred can be displayed as well as the bit status of both transmitting and receiving devices. If a particular test is successful, that too shall be indicated on the maintenance panel.
- d. Test Types. The self-tester shall simulate a particular computer and command the CC to enable a particular bus. The self-tester shall generate all the codes a computer would and begin transmitting data across the bus once the CC has properly configured the bus and receiving adapter. The self-tester shall monitor various points within the transmitting and receiving adapters at certain portions of the test and compare them with what it should be.

4.3.1.3 Self-Tester and Maintenance Panel. (Continued)

- e. Transmission Rates. The self-tester shall have the ability to vary the transmission rates to simulate the various rates that can be transmitted over the buses.

4.3.2 Shuttle Data Processing Complex (SDPC). The SDPC shall eventually replace the 494 computer complex and shall include the standard peripherals associated with the SDP. Certain functions previously performed by the 360/75 computers shall be off-loaded to the SDPC to free the 360/75 computers. The SDPC shall provide for processing of functions traditionally referred to as Command, Control, and Telemetry System (CCATS). To minimize the impact of transition from support of the OFT to support of the Operations (OPS), functions traditionally assigned to 360/75 which are expected to remain nearly stable throughout the transition shall be assigned to the SDPC, i.e., real-time telemetry and display processing.

The SDPC computers shall support mission-critical events and provide a batch processing capability to support software development and checkout during nonreal-time support periods. In a critical mission configuration, the system shall require one of three processors for support of time-critical processing, one processor system to run as a dynamic standby, and one processor to serve as a backup with selectover and restart capability. Figure 26 reflects those interfaces which make up the SDPC.

4.3.2.1 Shuttle Data Processor (SDP) Capability. The SDPC shall be an integral part of the Shuttle support system. There are requirements which are unique to the SDP as a single entry, to each Shuttle Data Processor (SDP) as it supports each function, and to all SDP's as they communicate, interconnect, and complement each other. The detailed capabilities of the SDP are defined in the RFP for the SDP.

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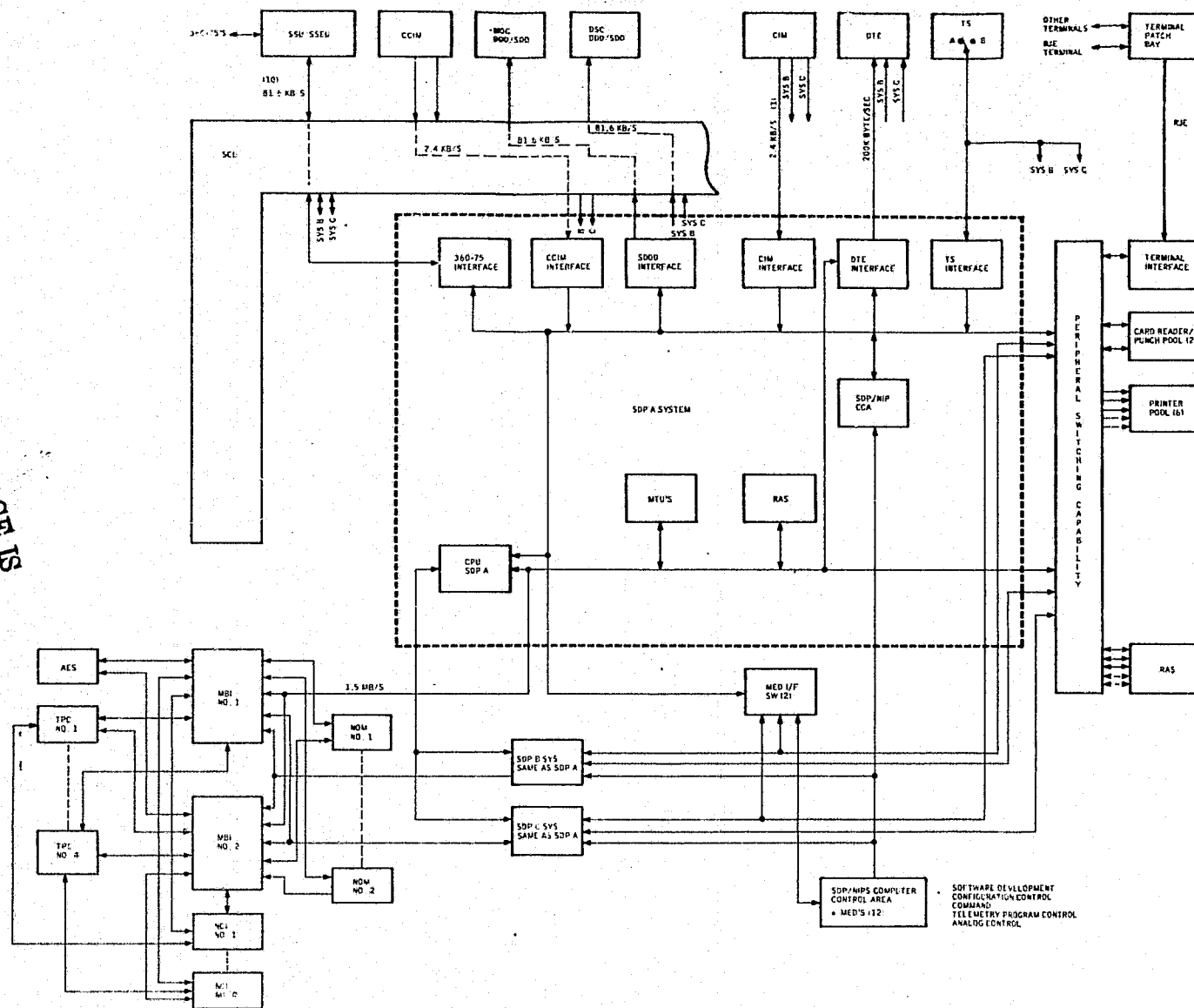


Figure 26 OFT SDPC Configuration

4.3.2.1 Shuttle Data Processor (SDP) Capability. (Continued)

Each SDP shall consist of a CPU, addressable memory, random access storage, and peripherals. The CPU shall have a processing capability of 3 million instructions per second (MIPS). Either one CPU or a maximum of two CPU's connected as a multiprocessor may be used to satisfy this requirement. A minimum of 16×10^6 bits of main storage shall be implemented for each SDP.

4.3.2.2 SDP Interface Capability. Each SDP shall be capable of interfacing with the CIS, the 360/75 Computer Complex, the DCS, the SDP Computer Control Area, other SDP's, and SDP peripherals. Refer to figure 12.

4.3.2.2.1 SDP/CIS Interface. The SDP/CIS interface capability shall consist of interfaces between each SDP and two MBI's, four TPC's, four NCIC's, two NOM's, an AES, and the TCS.

- a. SDP/MBI. Each SDP shall interface the MBI via an interface adapter (IA). There shall be two MBI's and therefore, two IA's per SDP to allow each SDP to communicate with either or both MBI's. The interface between the SDP and IA will be determined by the SDP. Some of the basic requirements for the MBI shall be:

- Rate - up to 1.2 megabytes/second per MBI adapter
- Width - parallel (eight bits or greater)
- Type - full-duplex
- Number - two interfaces per SDP.

This interface shall allow the SDP's to communicate with the four TPC's, two NOM's, four NCIC's, and an AES.

4.3.2.2.1 SDP/CIS Interface. (Continued)

- b. SDP/TPC. The SDPC shall interface with all TPC's via the MBI. The SDPC shall receive telemetry data for real-time processing from up to three TPC's for Shuttle OFT. The interface between the TPC and the SDP shall have the following general characteristics:
- Rate - up to 2 megabytes/second
 - Width - parallel (eight bits or greater)
 - Type - full-duplex
 - Number - two interfaces per TPC.
- c. SDP/NCIC. The SDPC shall interface with the four NCIC's via the MBI. The interface shall allow the SDP to provide configuration commands to the NCI defining which TPC will process which telemetry stream and what header codes will be valid for the current mission phase. The SDPC shall transfer these commands in variable block sizes of 16 to 4016 bits at a random rate. The NCI shall transmit site originated data and tracking data directly to an SDP in 4800-bit blocks at approximately six blocks per second. Each NCI shall also transmit configuration and error status, network communications statistics, and network headers directly to the SDPC in variable block sizes of from 16 to 160 bits at up to 500 blocks per second. The trajectory oriented data shall be throughput to the 360/75's with an option to log data in the SDP. The basic interface characteristics shall be:
- Rate - up to 360 kb/s
 - Width - parallel (eight bits wide or greater)

4.3.2.2.1 SDP/CIS Interface. (Continued)

- Type - full-duplex
 - Number - two interfaces per NCI.
- d. SDP/NOM. The NOM shall provide the MCC interface to the STDN command system for vehicle commands, site management commands, and acquisition data from the SDPC. The interface between the NOM's and the SDP's shall be via the MBI's. The MBI shall allow the data from the SDP to be transferred to any one of the two NOM's. The basic interface characteristics shall be:
- Rate - 230.4 kb/s
 - Width - parallel (eight bits wide or greater)
 - Type - full-duplex
 - Number - two interfaces per NOM.

4.3.2.2.2 SDP/360/75 Computer Complex Interface. Refer to paragraph 4.3.3.2.1.

4.3.2.2.3 SDP/DCS Interface. The SDP/DCS interface capability shall consist of interfaces between the SDP's and the Command/Computer Input Multiplexer (C/CIM), the Computer Input Multiplexer (CIM), Digital Television Equipment (DTE), the Subchannel Data Distributor (SDD), and the Timing Subsystem (TS). Refer to figure 12.

4.3.2.2.3 SDP/DCS Interface. (Continued)

- a. SDP/(C/CIM). The C/CIM shall multiplex commands and requests onto a single input channel to the SDPC. This line shall be switched to any one of three SDP's by the SCU. The serial input on each interface shall be assembled in 36-bit words. All words shall be transferred, starting with bit 0 and ending with bit 35. All characters comprising a word shall be transmitted with the MSB first. Some of the basic interface characteristics of this interface shall be:
- Rate - 2.4 kb/s ± 10 percent
 - Width - serial
 - Type - simplex from C/CIM
 - Number - two interfaces switchable through the SCU; one interface is for redundancy purposes only.
- b. SDP/CIM. The CIM shall multiplex and transfer a large number of request messages onto a single input channel to the SDPC. These requests shall be initiated from special function keyboards (DRK's, MSK's, SMK's, and etc.). Encoders shall detect and encode data into 36-bit word and transfer it to the SDP. Some of the basic interface characteristics shall be:
- Rate - 2.4 kb/s ± 10 percent
 - Width - serial
 - Type - simplex from the CIM
 - Number - three interfaces, one to each SDP.

4.3.2.2.3 SDP/DCS Interface. (Continued)

- c. SDP/DTE. Each SDP shall interface to the existing DTE; up to 10 DTE clusters shall be capable of being addressed and driven by each SDP. This interface shall allow CRT display data, TV channel configuration data, and TV channel saturation data to be displayed. Some of the basic interface characteristics for this interface shall be:
- Rate - 200 kb/s
 - Width - parallel (8-bit words)
 - Type - simplex data to DTE interface cabinet
 - Number - three, one interface per SDP.
- d. SDP/SDD. Each MOC and DSC SDP's drive an SDD interface. The interfaces shall be identical and have the following general characteristics:
- Rate - 81.6 kb/s
 - Width - serial
 - Type - simplex from the SDP
 - Number - one interface from each SDP to the SCU and interface from the SCU to each SDD (MOC and DSC).

This interface shall drive event lights and provide timing configuration data at various consoles.

4.3.2.2.3 SDP/DCS Interface. (Continued)

- e. SDP/TS. Each SDP shall be capable of accepting an existing external time input and external time pulses. The time and pulses shall originate in the TS and shall be transmitted to the SDP's via a chained interface; i.e., all SDP's shall be tied to a single interface on the TS. Three timing pulses shall be provided to each SDP: 1 pulse per second, 1 pulse per minute, and 100K pulses per second. The time input shall be GMT in a binary-coded decimal (BCD) format. Input shall be provided in parallel or serial. The GMT interface signals shall be updated at 1-second intervals and shall remain static between updates; nonreturn-to-zero (NRZ). The basic characteristics of the GMT time base are:

- Rate - GMT updates once every second
- Width - parallel (30 bits per GMT word)
- Type - simplex from TS
- Number - one interface looped between SDP's with switchable A and B time standard.

The SDPC vendor may select to use modified IRIG A or B serial time.

4.3.2.2.4 SDP/SDP Computer Control Area Interface. This interface shall provide the capability for Manual Entry Devices (MED's) and Restart Selectover (R/S) to interface with the SDP.

- a. SDP/MED. In support of the real-time processing function, each SDP shall have the capability to interface a total of 12 CRT MED's, which shall be furnished by the Government. These CRT MED's shall be used for program control and for generation of the Shuttle vehicle commands. These interfaces shall not be shared or switched between the SDP's; however, the MED's will be switched. These interfaces shall support data rates of 9.6 kb/s per MED.

4.3.2.2.4 SDP/SDP Computer Control Area Interface.
(Continued)

The CRT MED's shall be used by flight control and data systems personnel for command control and by the computer controllers for program control. The CRT MED's shall be switched by MCC systems external to the SDPC; they shall be switched to each SDP as required during mission support, in a mission operations computer/dynamic standby computer (MOC/DSC) environment, and during program development. The CRT MED's shall be located at cable distances of from 50 feet to 600 feet from any one SDP area. The following characteristics describe the CRT MED's:

- CRT screen display
- Alphanumeric display characters - approximately 4000
- Display characters - 96
- Display edit functions; such as cursor control, insert/delete character, insert/delete row, and clear screen
- Alphanumeric keyboard
- Program control function keys - 6 minimum
- Transmission capability - partial or full screen
- Error indications on data transfer
- CRT display hardcopy or parallel printout of CRT data
- Local display storage; tape cassette must be capable of specific block selection.

4.3.2.2.4 SDP/SDP Computer Control Area Interface.
(Continued)

- b. SDP/(R/S). When the SDP's are configured in a MOC/DSC configuration, a method shall be available to signal the two systems that a selectover will occur, i.e., the MOC shall become DSC and the DSC shall become MOC. This shall be accomplished by providing signals to the systems involved indicating selectover will occur and also indicating the status of the selectover. To indicate a selectover is to occur, a positive level (logical one) shall be sent to both the MOC and DSC. Once the SDP's receive this selectover interrupt, both systems must suspend their output operations until selectover has occurred; i.e., any message that has started from either computer shall be completed, but no new outputs shall be started. Under normal conditions, relays shall switch the outputs after 200 ms. In addition to the one interrupt line, each system shall be provided with three status lines which will present the status (improper, incomplete, or proper) of the selectover. The status shall be presented by putting a ONE or ZERO in various combinations on the three lines. All four lines and drivers shall be GFE, and the signals shall originate from GFE.

4.3.2.2.5 SDP/SDP Interface. The SDP's shall be interconnected for transfer of data between the SDP's for support of the mission restart function, for load sharing in the software development environment configuration, and for intercommunication between programs residing in different SDP's. The interconnection shall be provided for the three SDP's initially, and expanded to accommodate the two additional SDP's.

4.3.2.2.6 SDP/SDP Peripheral Interface. The type of peripherals required and quantity will be addressed in the following paragraphs.

- a. SDP/MTU. Each SDP shall have as a minimum six dedicated MTU's. One of these six MTU's shall be capable of a read and write speed of 120 inches per second (IPS) for a 9-track, 1600-bpi tape density, and read and write of 800 bpi tape density.
- b. SDP/Random Access Storage. This interface shall allow the SDP's to have access to a minimum of 1.6×10^9 bits. This storage shall be dedicated to each SDP. The average access time shall not be more than 35 ms.
- c. SDP/Printer. Six printers shall be provided for support of the local SDPC programming and support activities. These printers shall have the capability of being assigned in sets of two to a single SDP. Each printer shall have a print capacity of approximately 1200 lines per minute for a 96-character print set. Each line of print shall be at least 132 characters in length. Each printer shall be capable of being field-modified to a different print set of up to 128 characters.
- d. SDP/Card Reader/Punch. The shared system shall provide a total of three card readers and two card punches. The reader shall be capable of reading approximately 1000, 80-column cards per minute. The punch shall be capable of punching approximately 100, 80-column cards per minute. The control system shall be capable of assigning all readers and punches to any one SDP.

4.3.2.2.6 SDP/SDP Peripheral Interface. (Continued)

- e. SDP/RJE. Prior to the availability of the SDPC system for software development at JSC, the SDPC applications software development shall be conducted from RJE facility located in the IBM Bldg. to an offsite computer facility. Once an SDP is available for software development, the RJE terminal shall interface to the MCC.
- f. SDP/Communication Subsystem (CS/S). This CS/S shall provide capability for 150 users, with growth capability to support up to 450 users. The interface users shall consist of 33 percent 300 baud asynchronous users and 67 percent 2.4 to 9.6 kb/s synchronous users. The CTM shall be capable of being converted to support a distribution of 25 percent 300 baud asynchronous users and 75 percent 2.4 to 9.6 kb/s synchronous users; this conversion capability shall apply for the 150 users and the growth requirement of up to 450 users. The following types and rates shall be supported:
 - (1) Asynchronous, RS232 interface, compatible with American Standard Code for Information Exchange (ASCII), 8-bit character conventions, 300 baud.
 - (2) Synchronous, RS232 interface, compatible with ASCII, 8-bit character conventions, 2.4 to 9.6 kb/s, with capability to run (convert) all these interfaces at 9.6 kb/s.
 - (3) Capability shall be provided to interface two, 303C Bell System MODEM's at 50 kb/s.

CC/S shall provide capability for four host computers with growth capability to six. The known computers which shall be serviced are the UNIVAC

4.3.2.2.6 SDP/SDP Peripheral Interface. (Continued)

1108 and 1110 in Bldg. 12 and CYBER 74 in Bldg. 30. These requirements shall support the TCS functions which are now being supported by the UNIVAC 494's and shall be shifted to the SDPC.

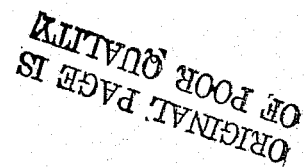
- g. SDP/Peripheral Switch. A peripheral switch may not be implemented, depending on the computer system selected; however, the capability to allow for pooling of the various SDPC peripherals shall be provided.
- h. SDP/Core Storage. Each SDP shall provide as a minimum 40×10^6 bits of storage. This storage may be a combination of main and extended main storage provided that a minimum of 16×10^6 bits is main storage and the remaining memory is extended main.

4.3.3 360/75 Computer Complex. The 360/75 Computer Complex shall provide OFT trajectory-related processing support such as ALSEP, LACIE, SDL, etc.

The existing 360/75 Computer Complex includes five IBM 360/75 computers, dedicated/shared peripherals, and system interface switching capability. The five computer systems are identified as A, B, D, E, and F; the systems are configured alike with the following exceptions. The F 360/75 has one 7-track tape unit in addition to the normal complement of 9-track tapes. The E system has no intercomputer channel-to-channel capability with the A, B, D, and F systems and no storage control capability or CCNU interface capability.

Switching of the various interfaces to the five 360/75's shall be controlled by string switches, the SSU, and the SSEU. The basic OFT 360/75 Computer Complex configuration is shown in figure 27.

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4.3.3.1 360/75 Computer Complex Capability. Each 360/75 system is equipped with a 2075 J CPU which contains 1,048,576 bytes of main storage. The cycle time of this storage is 750 ns. In addition to the main core storage each system is equipped with two 2361-2 Large Core Storage (LCS) units which provide an additional 4,194,304 bytes of storage. Using interleaving techniques, a cycle time of 4 μ s can be obtained. System E uses different hardware (Ampex ECM) other than IBM 2361-2 LCS and is able to obtain a 2 μ s cycle time.

Each 360/75 uses channels to transfer data between I/O devices and the CPU. The channel relieves the CPU of the burden of communicating directly with I/O devices and permits CPU operations to proceed concurrently with I/O operations. The 360/75 system has two types of channels, a multiplexer channel (MC) (2870) and a selector channel (SC's) (2860). One 2860-2 and one 2870-1 is attached to each 360/75.

The 360/75 2860 is implemented with two SC's (1 and 2). SC2 is capable of an I/O rate of 2.4 megabytes per second if the SC and control unit are within 10 feet of the CPU. The SC operates in a burst mode only. In this mode one device monopolizes the I/O interface and stays connected to the channel for the duration of an operation. Normally high-speed devices are connected to this type of channel. SC1 operates at a maximum I/O rate 1.2 megabytes per second.

The 2870 can operate in the burst mode or a multiplexer mode. In the multiplex mode, an MC can operate with more than one I/O device at a time. The 2870's implemented for each 360/75 have one MC and two selector subchannels (SSC's) which allow the MC to have a maximum I/O rate 66 kilobytes per second and SSC's to have a maximum I/O rate of 180 kilobytes per second. Normally, medium- and low-speed devices are connected to the 2870's.

4.3.3.2 360/75 Computer Complex Interface Capability. The 360/75 Computer Complex shall interface with the SDPC, the CIS, the DCS, 360/75 Computer Control Area, the 360/75-to-360/75 Interface, the SPP, the Flight Equipment Interface Device (FEID), and 360/75 peripheral interfaces.

4.3.3.2.1 360/75 Computer Complex/SDPC Interface. The 360/75-to-SDP interface shall allow trajectory data to be transferred from the SDP to the 360/75. It shall also provide the 360/75 the capability to respond to data requests from the SDP's.

The interface to or from the 360/75 shall be a serial simplex interface with an I/O rate of 81.6 kb/s. Each 360/75 shall have three identical interfaces consisting of four lines: the data line, the RTR line, the ready line, and the shift line.

During a mission configuration the MOC and DSC 360/75 shall receive data from the MOC SDP. Both the MOC and DSC 360/75 shall respond to the SDP data requests but only the MOC 360/75 data shall be allowed to interface with the MOC and DSC SDP. The DSC 360/75 data shall be bit-bucketed in the SSU/SSEU. Figure 28 shows how the 360/75 to SDP interface might be implemented.

4.3.3.2.2 360/75 Computer Complex/CIS Interface. Those interfaces which shall interface with the 360/75 Computer System from the CIS are the ALSEP, the Launch and Landing Radar, and possibly Wind Profile.

- a. 360/75 Computer Complex/ALSEP. The ALSEP interface shall provide a path for the lunar experiment package data to be input to and processed by the 360/75 Computer Complex. It shall also provide a path where ALSEP commands are transferred out via the CIS facility. The ALSEP interface is as it always has been except for the I/O rate. The I/O rate can be 9.6 or 7.2 kb/s. See figure 10. Some of the basic requirements for the ALSEP interface shall be:

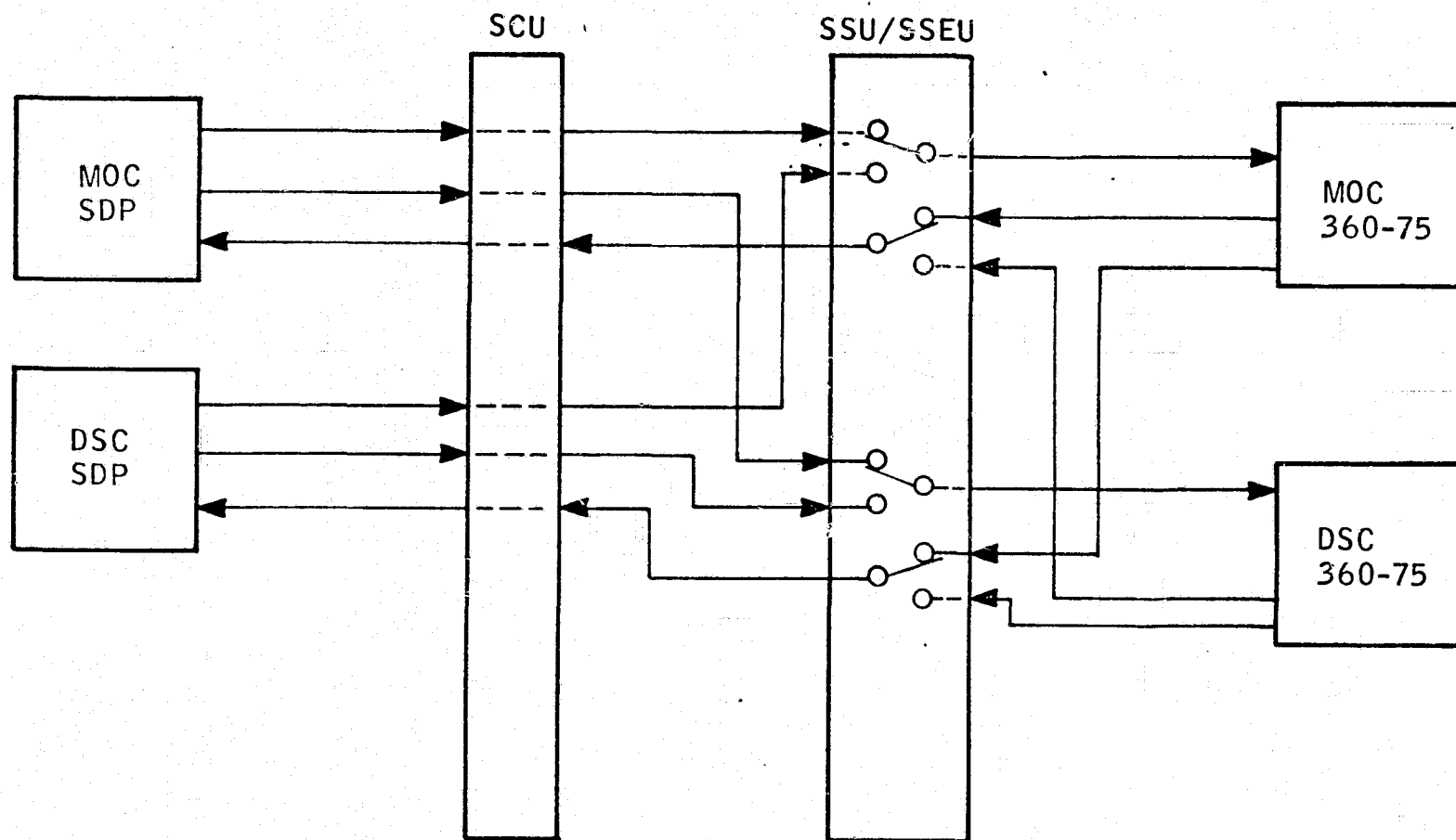


Figure 28 360/75 to SDP Interface Configuration

4.3.3.2.2 360/75 Computer Complex/CIS Interface. (Continued)

- Rate - 9.6/7.2 kb/s
- Width - serial
- Type - full-duplex
- Number - one.

b. 360/75 Computer Complex/Launch and Landing Radar.*

The Launch and Landing Radar data interface shall be provided via an IBM DCU-R/SSU/2902 data path. The basic characteristics of this interface from the DCU-R to the 2902 shall be:

- Rate - 2 kb/s
- Width - serial
- Type - simplex from the DCU-R
- Number - two interfaces which are patched in the SSU to two of the five 360/75's (MOC and DSC).

c. 360/75 Computer Complex/Wind Profile. The atmospheric model shall require the wind profile data to accurately predict Orbiter entry trajectory performance. An interface shall be provided which will allow the wind profile data to access all five 360/75's. The interface is being baselined as a direct hardwire interface via the SSU and 2902, however, this approach has not been confirmed by NASA and it is possible that data could be via a terminal or a card deck. If the interface is a hardwire-type the basic characteristics shall be as follows:

- Rate - 2 kb/s
- Width - serial

*This approach for IP may change due to problems with formats, data rates, and DCU-T's.

4.3.3.2.2 360/75 Computer Complex/CIS Interface. (Continued)

- Type - simplex RS232 interface to the 360/75's
- Number - one bus shall be routed to the SSU/SSEU and then patched to one of the five 360/75 2902's.

4.3.3.2.3 360/75 Computer Complex/DCS. The 360/75 Computer Complex shall interface the DCS via the DDD/SDD, Plotting Display Subchannel Data Distributor (PDSDD), DTE, ALCIM, ALSEP DACIU, ALSEP DDDIU, CIM, DRAFT, and TS.

- a. 360/75 Computer Complex/(DDD/SDD). This interface shall allow the designated MOC and DSC 360/75's to drive independent DDD/SDD's via the 2902 and SSU/SSEU path. The data output from the MOC and DSC 360/75's shall contain 36-bit words formatted into information blocks, with block lengths being variable as required by the source computer-resident function. Each computer word within the information block shall be individually addressed to permit the DDD/SDD to selectively date that word associated with a particular set of display indicators, trajectory recording pens, and/or TS's. The basic characteristics of this interface shall be:

- Rate - 81.6 kb/s
- Width - serial
- Type - simplex to the DDD/SDD
- Number - two of the five 360/75's (MOC and DSC) shall be patched within the SSU/SSEU and routed out to the DDD/SDD.

4.3.3.2.3 360/75 Computer Complex/DCS. (Continued)

- b. 360/75 Computer Complex/DTE. Each 360/75 shall have a separate interface with the DTE via an IBM 2701 serial line adapter. Each interface shall utilize a daisy-chain bus terminating technique to ensure that the data on any single 360/75 DTE data path appears as an input to all clusters. This interface allows CRT display data, TV channel configurations data and TV channel saturation data to be displayed. The basic characteristics of this interface shall be:
- Rate - 200 kb/s
 - Width - parallel (8-bit words)
 - Type - simplex to DTE interface cabinet via 2701 parallel data adapter
 - Number - one dedicated interface per 360/75 via a 2701.
- c. 360/75 Computer Complex/ALCIM. ALSEP command data for output to the GSFC shall be initiated by console devices and input to the ALCIM unit for throughput to the 360/75's. Commands are formatted, validated, and blocked for transmission by the system. The basic characteristics of this interface shall be:
- Rate - 2.4 kb/s
 - Width - serial
 - Type - simplex from the ALCIM
 - Number - one dedicated interface per 360/75 via the 2902.

4.3.3.2.3 360/75 Computer Complex/DCS. (Continued)

d. 360/75 Computer Complex/ALSEP DACIU. This interface shall allow each 360/75 to be patched in the SSU/SSEU to the ALSEP DAC's, SSCR's, etc. The basic interface requirements for this interface shall be:

- Rate - 13.6 kb/s
- Width - serial
- Type - simplex to the ALSEP DACIU
- Number - all five 360/75's 2902's shall provide an interface to the SSU/SSEU where one shall be patched to the ALSEP DACIU.

e. 360/75 Computer Complex/ALSEP DDDIU. This interface shall allow each 360/75 to drive the ALSEP DCS's. This shall be done by patching within the SSU/SSEU. The basic requirements for this interface shall be:

- Rate - 4.8 to 81.6 kb/s
- Width - serial
- Type - simplex to the ALSEP DDDIU
- Number - all five 360/75's 2902's shall provide an interface to the SSU/SSEU where one shall be patched to the ALSEP DDIU.

f. 360/75 Computer Complex/CIM. The CIM shall multiplex and transfer a large number of request messages onto a single input channel to the 360/75. These requests shall be initiated from special function keyboards (DRK's, MSK's, SMEK's, and etc.). Encoders shall detect and encode data into 36-bit words and transfer it serially to the 360/75. The

4.3.3.2.3 360/75 Computer Complex/DCS. (Continued)

special function keyboards shall allow special displays to be called up on TV monitors. Each 360/75 shall have a unique interface with the CIM via its dedicated 2902. The basic characteristics of this interface shall be:

- Rate - 2.4 kb/s
- Width - serial
- Type - simplex from the CIM
- Number - five interfaces, one for each 360/75.

- g. 360/75 Computer Complex/DRAFT. This interface shall be switchable to Bldg. 17 and shall have 360/75 interface via a 2701 parallel data adapter. It shall provide keyboard and cursor data inputs for calling up earth resources display menu's. The basic characteristics of this interface shall be:

- Rate - 40 words/second
- Width - parallel (16-bit words)
- Type - simplex from the DRAFT
- Number - one.

- h. 360/75 Computer Complex/PDSDD. The PDSDD shall provide the interface for the transfer and distribution of control signals and plotting data from the DCC to the group display equipment. This data shall control the generation of large-screen projection plotting displays. The basic characteristics of this interface shall be:

4.3.3.2.3 360/75 Computer Complex/DCS. (Continued)

- Rate - 40.8 kb/s
 - Width - serial (36-bit words)
 - Type - simplex to the PDSDD
 - Number - one of the five 360/75's shall be patched out to the PDSDD.
- i. 360/75 Computer Complex/TS. This interface shall provide BCD GMT time words and three different clock rates: 1 PPS on time, 1 PPS early, and 100 kb/s. Basic characteristics of this interface shall be:
- Rate - GMT updates once every second
 - Width - parallel (26 bits per GMT word)
 - Type - simplex from TS
 - Number - two interfaces shall be provided by the TS. Each interface shall be switchable to two time standards. One interface shall be connected to 360/75 A and B and the other interface shall be connected to 360/75 E, F and D.

4.3.3.2.4 360/75 Computer Complex/360/75 Computer Control Area Interface. This interface shall provide the capability for MED's, switch modules and R/S to interface with the 360/75.

- a. 360/75 Computer Complex/MED. Basic characteristics of this interface shall be:
- Rate - determined by operator speed but a maximum of 10 characters/second can be obtained for data transfer from the MED to the CCMU. Computer generated data shall be transferred to the MED at a rate of 100 wpm (6-characters/word)

4.3.3.2.4 360/75 Computer Complex/360/75 Computer Control
Area Interface. (Continued)

- Width - serial
- Type - standard TTY interface half duplex
- Number - 12 MED's shall be interfaced with the CAJU which in turn shall interface with the 360/75's via SSU, CCMU, and 2902.

The CAJU shall receive data and control signals from the MED's, notify the CCMU that data is available, and gate the data to the CCMU (via the SSU) when requested to do so. The CCMU shall convert the MED data from 8-level TTY characters codes to 6-bit binary characters and buffer messages of 96 characters or less from each MED.

- b. 360/75 Computer Complex/Switch Modules. The switch modules shall interface with the 360/75's via an CAJU/CCMU/2902 hardware. The switch module data control section of the CAJU shall exchange control signals with, and receive data from, the switch modules. The number of controls vary according to the type of switch module; however, a maximum of four control signals can be used with any module. The CAJU shall route the switch module input to the proper CCMU and transfer the data to the CCMU when it is ready. The data shall be transferred to the CCMU in 20-bit data words where the CCMU will then transfer this data serially to the 2902.
- c. 360/75 Computer Complex/R/S. R/S shall be accomplished by special modules which allow three basic functions to occur: switch the MOC and DSC, enable/disable the CCA's, and provide an Initialization Program Load (IPL) function. The modules presently consist of two types, the Complex Supervisor and

4.3.3.2.4 360/75 Computer Complex/360/75 Computer Control
Area Interface. (Continued)

the Operations Manager (OM). The functions and operation of the OM module as they apply to the CCA and IPL function are as follows: the restart function will load a computer from the MOC (either MOC1 or MOC2, depending on position of module switch 7). For the restart function there shall be five pushbutton switches, one for each computer. These switches shall be labeled RESTART A, RESTART B, RESTART D, RESTART F, and RESTART E. Depression of one of these switches will cause a core dump from the MOC, (MOC1 or MOC2, depending on mode of S7), to the computer associated with that particular switch. The five switches will be interlocked such that a restart cannot be performed with active MOC or DSC restart switches on the module. In addition, the OM module will be interlocked with the Complex Supervisor's Computer Availability module in such a way that the computers selected as MOC and DSC on the R/S module cannot be selected as the restart computer on the other modules. This will require that the thumbwheel switch selections are correctly maintained with respect to the illuminated MOC and DSC indicators. Depression of a RESTART pushbutton switch will cause the following action:

- (1) The appropriate CCA shall be enabled. Enabling the CCA shall consist of a Form A contact closure.
- (2) A 4-bit address shall be transmitted to the selected computer which will select the appropriate CCA.

4.3.3.2.5 360/75 to 360/75 Computer Interface. This interface shall handle data involved in a core dump when restart from MOC or DSC occurs. All intercomputer communication shall be handled via a CCA which interfaces directly to an IBM 2860 SC. General characteristics of this interface shall be:

- Rate - channel rate
- Width - parallel (eight bits wide)
- Type - half duplex
- Number - all 360/75's can communicate with each other via CCA's except System E.

4.3.3.2.6 360/75 Computer Complex/SPP Interface. The SPP shall augment the Data Processing System planned in support of LACIE. This processing system is in development as an extension of existing JSC image analysis capabilities, and specifically of the ERIPS currently operational on an IBM 360/75 in the RTCC.

The LACIE Data Processing System shall accept, store, and process data that has been acquired by the LANDSAT-B satellite multispectral scanner (MSS), preprocessed at GSFC and transmitted by tape to JSC in a universal format. The imagery data and associated peripheral data shall be stored in various data bases located on disk storage peripheral to the 360/75's. The data shall be processed automatically after certain information and control parameters have been specified to these data bases. The LACIE applications programs shall reside on any one of five 360/75's, all of which have an interface to the disk storage. The total immediate access to storage requirements to support these applications (near the end of the growing season) is expected to be 4.2 billion bytes plus data management overhead.

The SPP can interface any two 360/75's via 2860 SC's. These two interfaces are switched to the different 360/75's by IBM 2914

4.3.3.2.6 360/75 Computer Complex/SPP Interface. (Continued)

string switches. The general characteristics of this interface shall be:

- Rate - up to SC2 maximum rate
- Width - parallel (16 bits)
- Type - half duplex
- Number - maximum of two interfaces.

4.3.3.2.7 360/75 Computer Complex/Peripheral Interfaces.

The 360/75 Computer Complex has a complement of dedicated and shared peripherals which support its input, output, processing, and storage functions. These peripherals shall involve tapes, disks, printers, card reader/punch, printer keyboards, interactive terminals, and storage capability. Figure 27 shows a detailed configuration of the 360/75 dedicated and shared peripheral hardware.

- a. 360/75 Computer Complex/Tape Drives and Associated Equipment. Each 360/75 computer shall have a complement of four 2401-3 type tape drives attached to each SSC of each 2870 in the 360/75 complex. The basic characteristics for these drives shall be:

- Number of tracks - 9
- Dual density capability - none
- I/O rate - 90 kb/s
- Density - 800 bytes/inch
- Tape Speed - 112.5 IPS
- Nominal interrecord gap - 0.6 inch

4.3.3.2.7 360/75 Computer Complex/Peripheral Interfaces.
(Continued)

- Data recorded in parallel - eight bits for data, one bit parity
 - Controller - built into the 2403-3.
- b. 360/75 Computer Complex/Disk Drives and Associated Equipment. Each 360/75 computer shall have one dedicated low-speed 2314 Direct Access Storage Facility attached to SC1 of its associated 2860 SC. In addition each 360/75 SC2 interface can be switched to two high-speed disk pools. Refer to figure 27. The large disk pool (42 disk drives) shall be used for the LACIE application while the smaller pool (4 disk drives) shall be used by all users. The characteristics of each direct access storage facility shall be:

(1) Low-Speed

- Type - IBM 2314 Disk Drives
- Number of disk drives - 8
- Storage capability - 29 megabytes/disk
- Number of disks - 8 (2316)
- I/O rate - 312 bytes/second
- Access times - 25 ms minimum, 75 ms average, 135 ms maximum
- Number of paths into low-speed pool - 1
- Controller - built into the 2314.

4.3.3.2.7 360/75 Computer Complex/Peripheral Interfaces.
(Continued)

(2) High-Speed

- Type - ITEL 7330 Disk Drives
- Number of disk drives - 42 for LACIE pool and 4 for the other pool
- Storage capacity - 100 megabytes/disk
- I/O rate - 806,000 bytes/second
- Access Time - 7 ms cylinder to cylinder, 27 ms average, 50 ms maximum
- Average Latency Time - 8.4 ms
- Total paths into pool - 2 for the LACIE pool and 4 for the smaller pool
- Controller - 7830.

c. 360/75 Computer Complex/Printer and Card Reader Punch. Each 360/75 shall have access to a printer/card reader punch pool consisting of 13 printers (eight 1403's and five 1443's) and 6 card reader punches (2540's). The card reader punch controller shall be a 2821. The 360/75 shall access the pool via the 2870 MC and the multiplexer string switches. Refer to figure 27. The different printer and card reader punch characteristics shall be as follows:

(1) Low-Speed (1443-NI) Printer

- Number of print positions (FC 5558) - 120 + 24
- Number characters - 52

4.3.3.2.7 360/75 Computer Complex/Peripheral Interfaces.
(Continued)

- Number lines/minute - 240
- Total cycle time - 250 ms
- Controller - built into the 1443.

(2) High-Speed (1403-N1) Printer

- Type printer - chain
- Number of characters - 48
- Number lines/minute - 1100
- Cycle time - 54.5 ms
- Controller - 2821.

(3) Card Reader

- Reading speed - 1000 cards/minute
- Hopper capacity - 3100 cards.

(4) Card Punch

- Punching speed - 300 cards/minute
- Hopper capacity - 1350 cards.

d. 360/75 Computer Complex/Printer Keyboard and Associated Equipment. Each 360/75 shall have two printer keyboards (1052-7) attached to their 2870 MC. The characteristics of the printer keyboard shall be:

- Number of printing positions - 125

4.3.3.2.7 360/75 Computer Complex/Peripheral Interfaces.
(Continued)

- Printing rate - 15.5 characters/second
 - Accepts Extended Binary-Coded Decimal Interchange Code (EBCDIC) coded data
 - Associated controller - built into 1052.
- e. 360/75 Computer Complex/Interactive Terminals. The 360/75 Computer Complex has three types of interactive terminals implemented in its system.
- (1) IBM 2260 terminals are implemented outboard of the Multiplexer String Switch and are used with the ALSEP, LACIE and SDL functions. The characteristics are as follows:
- Rate - 2400 bp/s
 - Characters per display - 960 (12 rows, 80 columns, 10 bits/character)
 - Number of strings - 3 SDL, 1 ALSEP/LACIE
 - Number of terminals - 10.
- (2) IBM 3277 terminals are implemented outboard of the multiplexer string switch (four attached support processing (ASP) terminals in the MCC and seven time share option (TSO) terminals located in the IBM building) to improve program control and programmer efficiency. The characteristics are as follows:
- Rate - local 680 kb/s, remote 7200 bp/s
 - Characters per display - 1920 characters (8 bits/character)

4.3.3.2.7 360/75 Computer Complex/Peripheral Interfaces.
(Continued)

- Number of strings - 1 ASP, 1 TSO
 - Number of terminals - 11.
- (3) Two Information Management System (IMS) terminals (2740's) are located outboard to the multiplexer string switch. The 2740 does not include a display but it does feature a Selectric typewriter appropriately modified for use as a general purpose communication terminal; i.e., 1100 lines/minute, 54.5 ms cycle time, and a 2821 controller. Characteristics are as follows:
- Rate - 14.8 characters/second
 - Number of strings - 2 IMS
 - Number of terminals - 2.
- f. 360/75 Computer Complex/Storage. Each 360/75 system has a 2075J CPU which contains 1,048,576 bytes of main storage. Each system except System E has an additional LCS of two Model 2361-2's attached. Each 2361-2 has a storage capacity of 2,097,152 bytes. System E has four Ampex Extended Core Storage (ECS) modules implemented with 4,096,000 bytes of storage. The cycle rate of the Ampex ECS is 2 μ s which is twice as fast as the interleaved 2361 LCS modules.
- g. 360/75 Computer Complex/Channel Controller. Each 360/75 system has a 2870 MC implemented with a multiplexer subchannel (MSC) interface and two SSC interfaces. The MSC is a low-speed interface that

4.3.3.2.7 360/75 Computer Complex/Peripheral Interfaces.
(Continued)

can operate in a byte interleaved mode (multiplex) or in a burst mode. This particular interface is used to interface low-speed devices. Figure 27 shows this interface connecting to the Multiplexer String Switch and the 2902 MLA. The Multiplexer String Switch allows this interface to access the printer/card reader punch pool, ALSEP/LACIE terminals, ASP/TSO terminals, IMS terminals and DRAFT.

The 2902 allows the MSC interface to receive or transfer data to those interfaces identified in figure 29. The 2870 SSC1 and SSC2 interface with the dedicated tape drives (four on each SSC). The SSC2 also interfaces with a string switch which allows access to the FEID's via a 2701. The I/O rate of the SSC interfaces is 180 kb/s. Each 360/75 has a 2860-2 SC implemented in its system. Each 2860 is implemented with two SC interfaces (SC1 and SC2). SC1 interfaces with the dedicated disk storage and a CCA. The maximum I/O rate possible is 1.2 Mb/s. Generally the rate is much less depending on cable length. The SC2 interface has been modified to allow a maximum I/O rate of 2.4 Mb/s. SC2 interfaces with a CCA, a string switch and the DTE 2701. The string switch allows access to all high-speed disk pools, the SPP and the three FEID strings. The SC1 and SC2 interfaces are used with high-speed devices.

4.3.4 UNIVAC 494 Computer System. Control of the Terminal Control Subsystem (TCS) shall be the primary function of the UNIVAC 494 Computer Complex. Two 494's (System B and C) associated peripheral hardware, the Terminal Communication Control Element (TCCE), 494/360 adapters, and Communication Line Terminals (CLT's) make up the 494 Computer System.

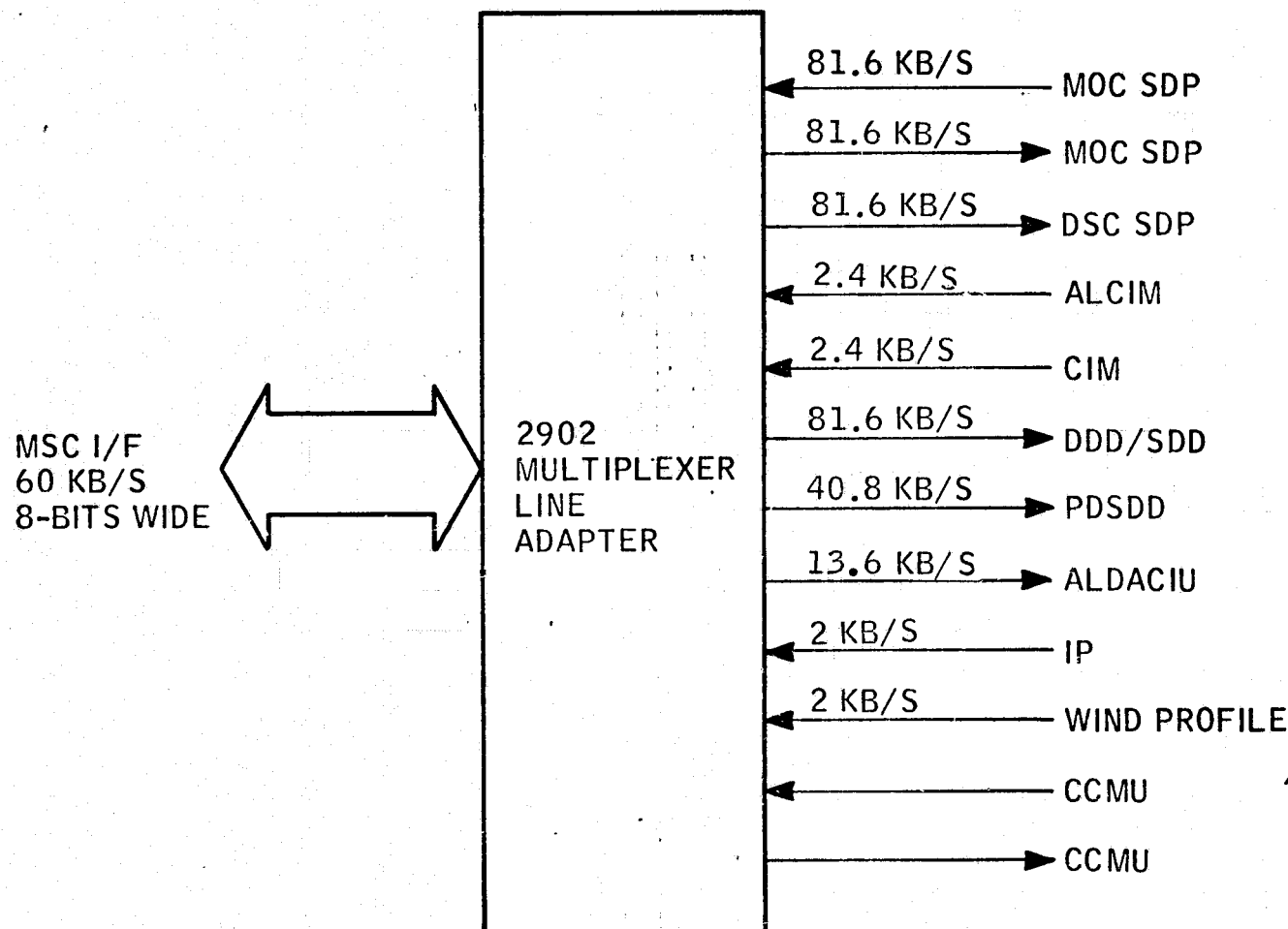


Figure 29 Multiplexer Line Adapter Interfaces

4.3.4 UNIVAC 494 Computer System. (Continued)

The UNIVAC 494 computers route the TCS data from the Terminal Patch and Test Facility through a 4-way switch to eight Communications Terminal Multiplexer Cabinets (CTMC's), or Communication Line Terminals (CLT's) which are terminal interfaces. The 4-way switch provides the switching of the CTMC's and CLT's to either one of two 494 computers. The computers then route the terminal data to one of two interfaces, either the 494/360 adapters or the WBD CLT's. Both the adapter and the CLT's interface with the System Configuration Unit (SCU).

Sometime during the early part of 1980 the TCS function will be assumed by the SDP Computer Complex and the 494 Complex will be removed from the DCC.

4.3.4.1 494 Processing Element. The processing element shall be capable of manipulating and routing large quantities of constantly changing, complex data on a real-time basis by utilizing two computer systems as shown in figure 30. Each computer system shall consist of one main frame, one computer control console, and peripheral devices as described in the following paragraphs.

4.3.4.1.1 Main Frame. The main frame shall be a UNIVAC 494 real-time computer with control, arithmetic, storage, and I/O sections, plus related power supplies and a maintenance panel.

- a. Control Section. The control section of the computer shall interpret and sequence computer instructions and have the responsibility of accepting data and tasks from external equipment, queueing tasks in conformance with demands of a real-time system, processing these tasks, and returning results to external equipment. The control section shall provide control of all computer operations except certain I/O functions.

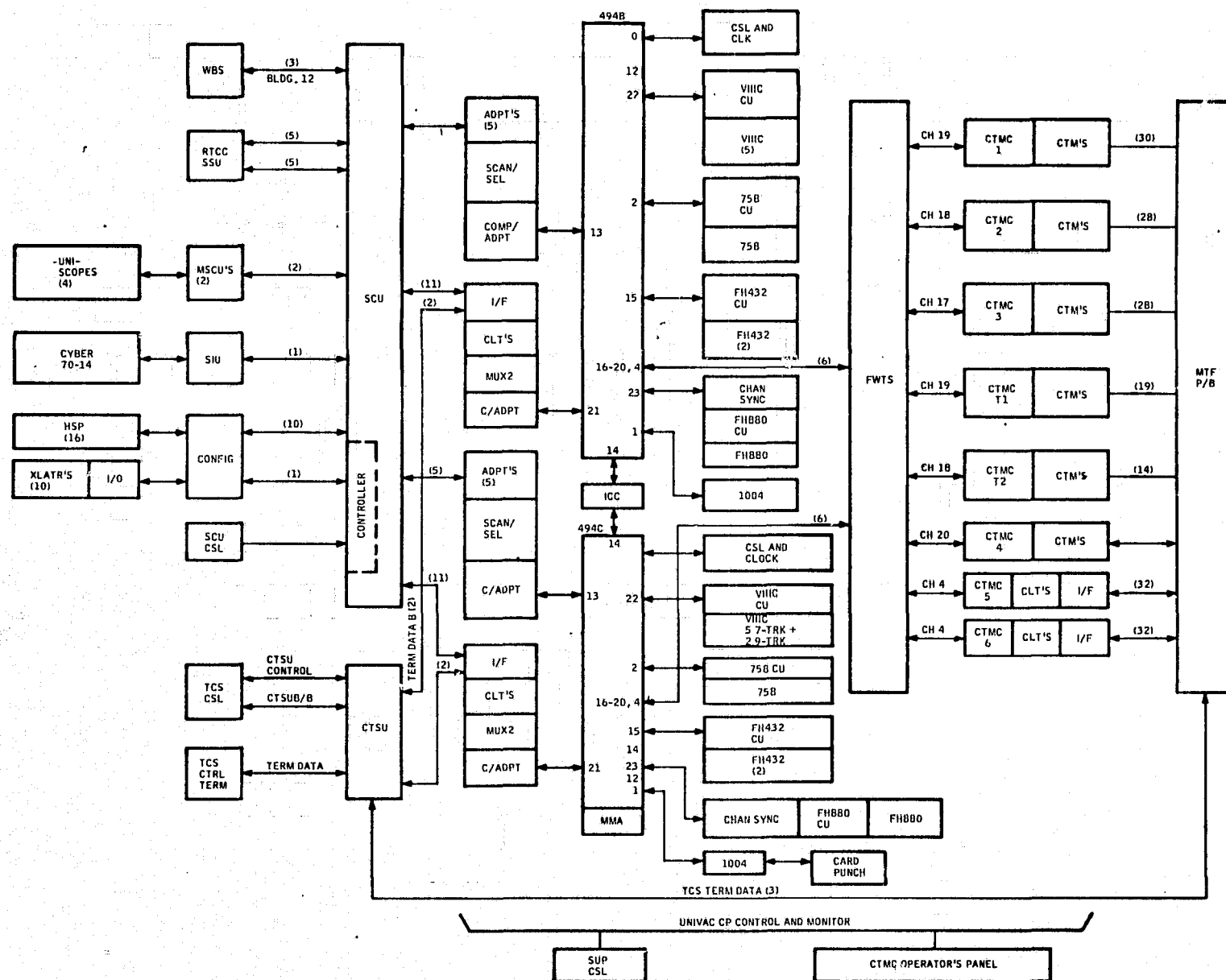


Figure 30 494 Computer Complex and Associated Interfaces

4.3.4.1.1 Main Frame. (Continued)

- b. Arithmetic Section. The arithmetic section of the computer shall perform numeric and logical calculations.
- c. Storage Section. The computer memory section shall comprise a high-speed, random access (half and full words), large-capacity nonvolatile core-storage unit of 131,072 30-bit words (plus parity for each half word). The memory section shall be capable of operation in the overlap mode to reduce effective instruction time below that of memory cycle time. The core storage unit shall store the operational program that is used by the computer control section to determine the method of processing incoming and outgoing data and provide temporary storage for processed data.
- d. Input/Output Section. The computer shall communicate directly with many types of digital peripheral equipment including other computers. Such communication, which includes both data and control information, shall be performed at a rate determined by the operating speed of the peripheral unit and the computer. Twenty I/O channels shall be provided on each computer. Transmission to and from a computer via these channels shall be in the form of successive 30-bit computer words.

The I/O channels shall be separated into three groups of eight channels each. The first group shall be composed of eight compatible channels (0 through 7). The second group shall be composed of four normal channels (12 through 15), expandable by an additional four normal channels (8 through 11). The third group shall be composed of eight compatible channels (16 through 23). The normal and compatible channels shall have transfer rate capabilities of 555,000 and 250,000 computer words per

4.3.4.1.1 Main Frame. (Continued)

second, respectively. Channel 0 shall accommodate both the computer control console and the day clock. The remaining channels shall be used for communications between the computer and its peripheral devices, the communications element, the control element, and the TCCE.

4.3.4.1.2 Computer Control Console. The computer control console shall be an I/O device for programming and monitoring the computer operation. Each computer shall have a desk-type control console that consists of a keyboard MED, a printer, a logic control unit, a day clock, a control panel, and a power supply. The computer control console shall interface with Channel 0 of the computer.

4.3.4.1.3 Computer Peripheral Devices. Various peripheral devices shall be required in the CCATS for computer auxiliary storage, man-machine interface, and input/output. These shall consist of one FH-880 Magnetic Drum System, one FH-432 Magnetic Drum System, one Magnetic Tape System, one 1004 card processor, one 0758 high-speed printer, and one intercomputer coupler (ICC) per computer system.

- a. FH-880 Magnetic Drum System. The FH-880 Magnetic Drum System shall consist of one FH-880 magnetic drum storage unit (MDSU) with an associated control unit. The MDSU of each computer is a large capacity, high-speed random access storage device used for program storage and temporary data storage. The MDSU consists of a magnetic drum, 40 flying head blocks containing 22 read-write heads in each block, and the necessary read-write circuitry and power supply requirements. The MDSU is capable of storing, 786,432 computer words of 30 bits each and has an average access time of 17 milliseconds. The Magnetic Drum Control Unit (MDCU) controls the storage

4.3.4.1.3 Computer Peripheral Devices. (Continued)

and retrieval of data transfers between the storage unit and the computer. The MDCU adapts signal levels, controls the speed of data flow, and maintains a constant error check on data read from the MDSU. The MDCU is capable of controlling any one of up to eight MDSU's. It has a channel synchronizer and is interfaced with a compatible computer channel at a data transfer rate of 60,000 computer words per second.

- b. FH-432 Magnetic Drum System. The FH-432 magnetic drum system shall consist of two FH-432 MDSU's with an associated control unit. MDSU's of each computer are high-speed random access storage devices used for program storage and temporary data storage. Each MDSU consists of a drum, nine flying head blocks containing 54 read-write heads in each block, and the necessary read-write circuitry. The MDSU is capable of storing 262,144 computer words of 30 bits each and has an average access time of 4.3 ms. MDCU controls the storage and retrieval of data transfers between the storage unit and the computer. The MDCU adapts signal levels, controls the speed of data flow, and maintains a constant error check on data read from the MDSU. The MDCU is capable of controlling any one of up to eight MDSU's to be interfaced with a normal channel of the computer at a data transfer rate of up to 240,000 computer words per second.
- c. Magnetic Tape System. The Magnetic Tape System for each computer shall consist of a magnetic tape control unit (MTCU), five magnetic tape units (MTU's), and related power supply requirements.

4.3.4.1.3 Computer Peripheral Devices. (Continued)

- (1) Magnetic Tape Control Unit. The MTCU of each computer controls and temporarily stores incoming and outgoing data. It can service up to 16 Uniservo VIII C MTU's. The MTCU decodes instructions from the computer and translates the instructions into proper routing of data and tape transport motion. The MTCU has a channel synchronizer and is capable of being interfaced to a compatible computer channel or to a normal computer channel.
 - (2) Magnetic Tape Units. The five MTU's are UNIVAC Uniservo VIII C MTU's that are used for initial loading of the operational program into the computer and for logging data during operations. The MTU's are also used for magnetic core and drum dumps. Each MTU contains read amplifiers and write drivers for each of seven channels, read and write heads, and the tape transport mechanism. Each MTU may utilize 1200-foot or 2400-foot tape reels. The tape speed is 120 IPS for data transfer and 240 IPS when re-winding. The recording density may be set at the MTCU or selected by the computer. The recording density may be 200, 556, or 800 frames per inch, with each frame containing six data bits plus odd or even parity as selected by the computer.
- d. 1004 Card Processor. The UNIVAC 1004 card processor of each computer reads information from cards into the computer memory and prints out information from core memory, drum storage, and magnetic tape. The card processor consists of a high-speed 400-LPM line printer, a 400-card per minute card reader, a processor with 961 characters of core storage, a power supply, and a maintenance panel. The 1004 card processor is interfaced to a compatible computer channel.

4.3.4.1.3 Computer Peripheral Devices. (Continued)

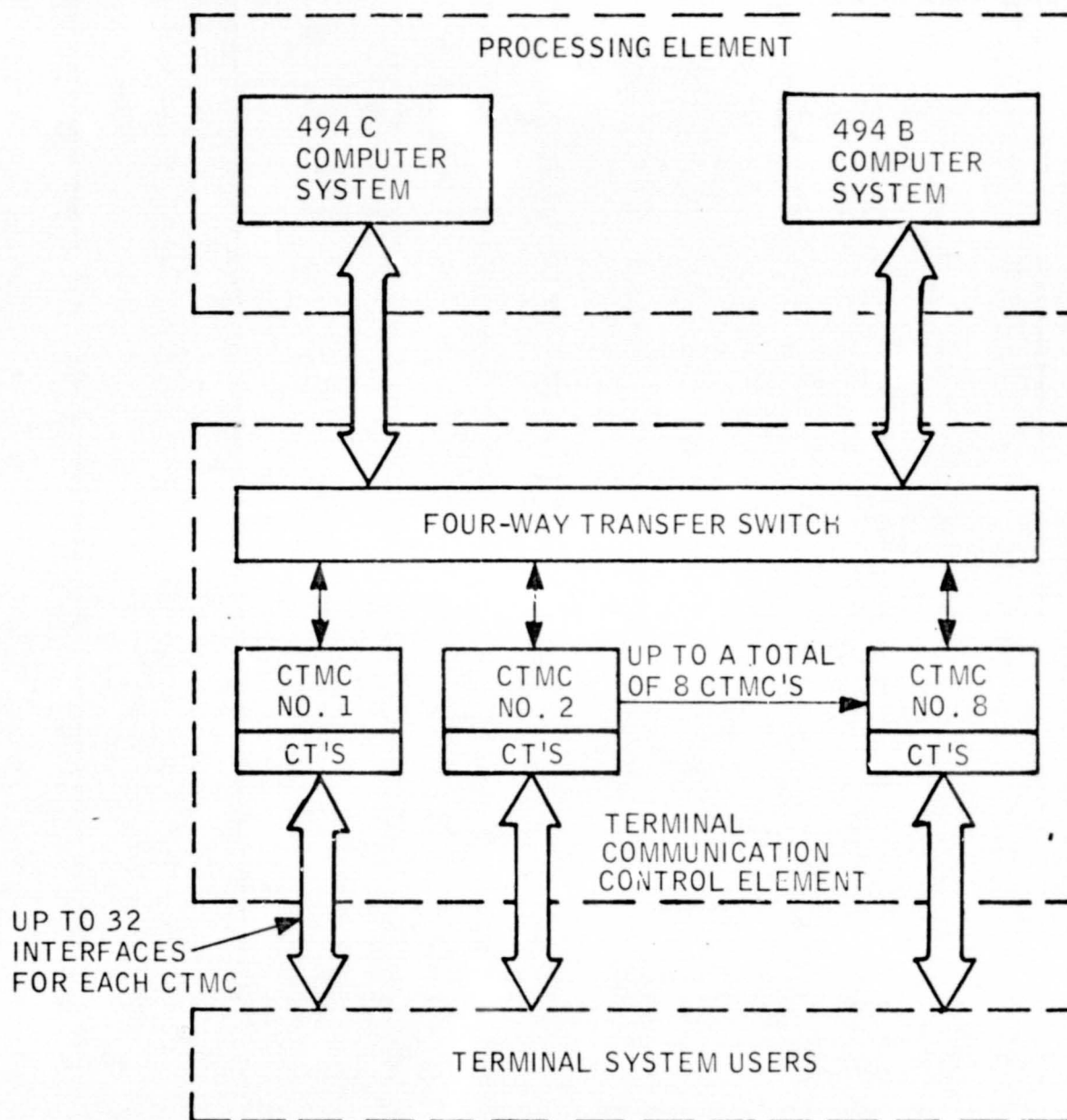
- e. 0758 High-Speed Printer and Control Unit. The 0758 high-speed printer is a high-speed line printer utilized to provide output of large quantities of data generated by the computer. The 0758 high-speed printer of each computer prints program selected data from core memory, drum storage, and magnetic tape. The high-speed printer consists of a printer, paper drive assembly, logic decks, and a power supply. The printer is capable of printing the full 63 alphanumeric character set at a rate of 1200 LPM. There are 43 contiguous alphanumeric characters in this set which may be printed at a rate of 1600 LPM. The printer has a line spacing speed of 11.5 ms for spacing the first line, and 5.06 ms at a rate of 8 lines per inch for the second or each subsequent line. The number of lines per inch is selectable by a switch located on the printer. The high-speed printer control unit of each computer provides the interface and control between a compatible computer channel and the 0758 high-speed printer. The control unit contains a buffer memory which stores 27 30-bit words for printout of one line of data (132 6-bit character codes). A seventh bit is stored in the buffer memory to indicate whether or not the character is to be printed. The seventh level will contain a 1 bit for each character to be printed and a 0 bit for each character that is not to be printed.
- f. Intercomputer Coupler. One ICC is provided between the 494's to allow for intercomputer communication. The ICC is interfaced to a normal computer channel, and operates in the Internal Specified Index (ISI) mode. The ICC allows for intercomputer communication by use of external function words, external interrupts and parallel 30-bit data transfers. The ICC is used in conjunction with the Restart Control Module for restart of a 494 computer. The ICC is capable of full-duplex demand-response parallel data

4.5.4.1.3 Computer Peripheral Devices. (Continued)

transfers between two 494 computers. The ICC uses control signals similar to those used by the Restart Control Module to perform intercomputer data transfers.

4.5.4.2 Terminal Communication Control Element. The TCCE shall provide the interface between the processing element and the terminal system users. The TCCE shall consist of three basic elements: the Communication Terminal Module Controller (CTMC), the Communication Terminal Module (CTM) and the 4-Way Transfer Switch (FWTS). See figure 31. Each CTM is composed of two communication terminals (CT). The principal functions of the TCCE are to provide for serial-to-parallel and parallel-to-serial conversions for terminal system user interfaces, to allow time multiplexing of several of these interfaces on each computer I/O channel and to provide interface capability for terminal system users to any of the two 494's. The TCCE provides the capability to interface between each of the two 494's to the terminal system users for low-speed, medium-speed, and high-speed data, and WBD. The TCCE shall provide the capability to interface 300 terminal system users to any one of the two 494's.

4.3.4.2.1 Communication Terminal Module Controller. The CTMC shall provide the interface between the CT's and the communication processor (CP) via the FWTS. Each CTMC is capable of handling up to 32 CT's. An equal number of input and output CT positions are provided. For example, a 32-position CTMC accommodates up to 32 input and 32 output CT's. Each CT is handled on a priority basis upon submitting a request for service. The highest priority request locks out all others until its request has been handled. Up to six CTMC's may be connected directly to the UNIVAC 494.



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Figure 31 TCCE System Block Diagram

4.3.4.2.2 Communication Terminal. The input CT shall assemble the users serial data and transfer it in parallel to the CTMC for transmission to the CP. The output CT shall accept parallel data from the CP via the CTMC and transfer the disassembled serial data to the terminal system user. Each character shall consist of seven bits plus an even parity bit. The LSB shall be received or transmitted first. The input and output CT's shall be capable of interfacing with asynchronous or synchronous terminal interface lines. The asynchronous terminal interface lines shall consist of low-speed and medium-speed data at one of the following rates: for low-speed, 110, 150, and 300 bits per second; for medium-speed, 600, 1200, and 1600 bits per second. The synchronous terminal interface lines shall be composed of high-speed and WBD at one of the following rates: for high-speed, 2000, 2400, 4800, 7200, and 9600 bits per second; for WBD, 40.8 and 50.0 kb/s.

4.3.4.2.3 Four-Way Transfer Switch. The FWTS shall provide the capability to allow switching of any of up to six CTMC channels to any one of the two 494's. The FWTS shall provide for relay switching of all data and control signals between each CTMC channel and each CP.

The FWTS shall have the following control capabilities:

- a. Remote control to allow configuration of each CTMC channel to any one (and only one at a time) of the two 494's is provided. Each CTMC channel shall be switched independently. The control status of each CTMC channel shall be indicated at the remote control panel.
- b. Local control to allow the same configuration capability as in paragraph a is provided. The FWTS shall have the capability of selecting either local control or remote control.

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4.3.4.3 494/360 Adapters. The 494/360 adapters shall provide the interface between the 494 computers and the CYBER 74 and/or the 360/75 computer systems. Each 494/360 adapter shall consist of one scanner selector, five full duplex adapter units.

The operational requirements are as follows. The 494/360 adapter shall allow the UNIVAC 494 computer to transfer data to and receive data from an external device utilizing a full duplex demand/response IBM RT12108-type interface at a serial synchronous data rate of up to 81,600 bits per second. The 494/360 adapter shall be configured with the SCU to interface with the RTCC via the IBM SSU/SSEU and the CYBER via 494/CYBER adapter.

4.3.4.4 Communication Line Terminal. The UNIVAC CLT shall establish connection between the computer and the user's communications facilities. The input CLT shall assemble the user's serial data and transfer it to the computer. The output CLT shall accept the computer's parallel data and transfer it to the user as disassembled serial data. The input and output CLT's shall be provided in three basic types: asynchronous high-speed (up to 4800 bits per second), synchronous, and wideband (up to 50,000 bits per second).

A timing source (clock) shall be required by all CLT's to establish the proper sequencing of data bits or characters as they are transferred to and from the communication facilities. The timing source shall be supplied either by the communication facility or by the TS.

4.3.5 DCC-to-MCC Systems Configuration and Switching Equipment. In addition to the MBI specified in paragraph 4.3.1, the following equipment shall be used to interface and configure the DCC computer systems with MCC's communications, display, and control systems. This equipment shall consist of the SCU, the SSU/SSEU, and 360/75 String Switch.

4.3.5.1 System Configuration Unit (SCU). The SCU shall provide switching and routing capability for circuits requiring SDPC and/or 360/75 and/or 494 processing. The SCU shall provide the switching necessary for rapid reconfiguration of a MOC to DSC switchover. It shall provide semiautomatic or manual configuration changes of those lines which are not protected by a MOC/DSC configuration mode. The SCU shall provide switching capability for up to 200 inputs to 200 output ports. All inputs shall be converted to a common logic level within the SCU and the outputs shall be converted to logic levels compatible with the receiving device. The SCU shall be capable of operating at any data rate up to 100 kb/s. The SCU shall comprise a control console, an advisory printer, a configuration controller, and two switch matrices, as illustrated in figure 32.

4.3.5.1.1 SCU Control Console. The SCU Control Console shall consist of a control panel mounted in the CCATS configuration controller console. The control panel shall provide the capability to operate the configuration controller in either the semiautomatic mode or the manual mode of operation. In addition, system controls shall be provided which are independent of the mode of operation of the Configuration Controller. The capability to initiate a map of all closed crosspoints in each switch matrix shall be provided as well as the capability to initiate an Automatic Fault Detection/Fault Isolation Routine.

4.3.5.1.2 High-Speed Printer. The HSP shall provide the capability to advise the system operator of the crosspoint status of both switch matrices and provide printout capability for information punched on paper tape. Crosspoint status printouts shall be available in two formats. In addition, display capability shall be provided in the form of an advisory when the automatic fault detection operation is exercised. For detailed information on the HSP reference paragraph 4.3.3.1.

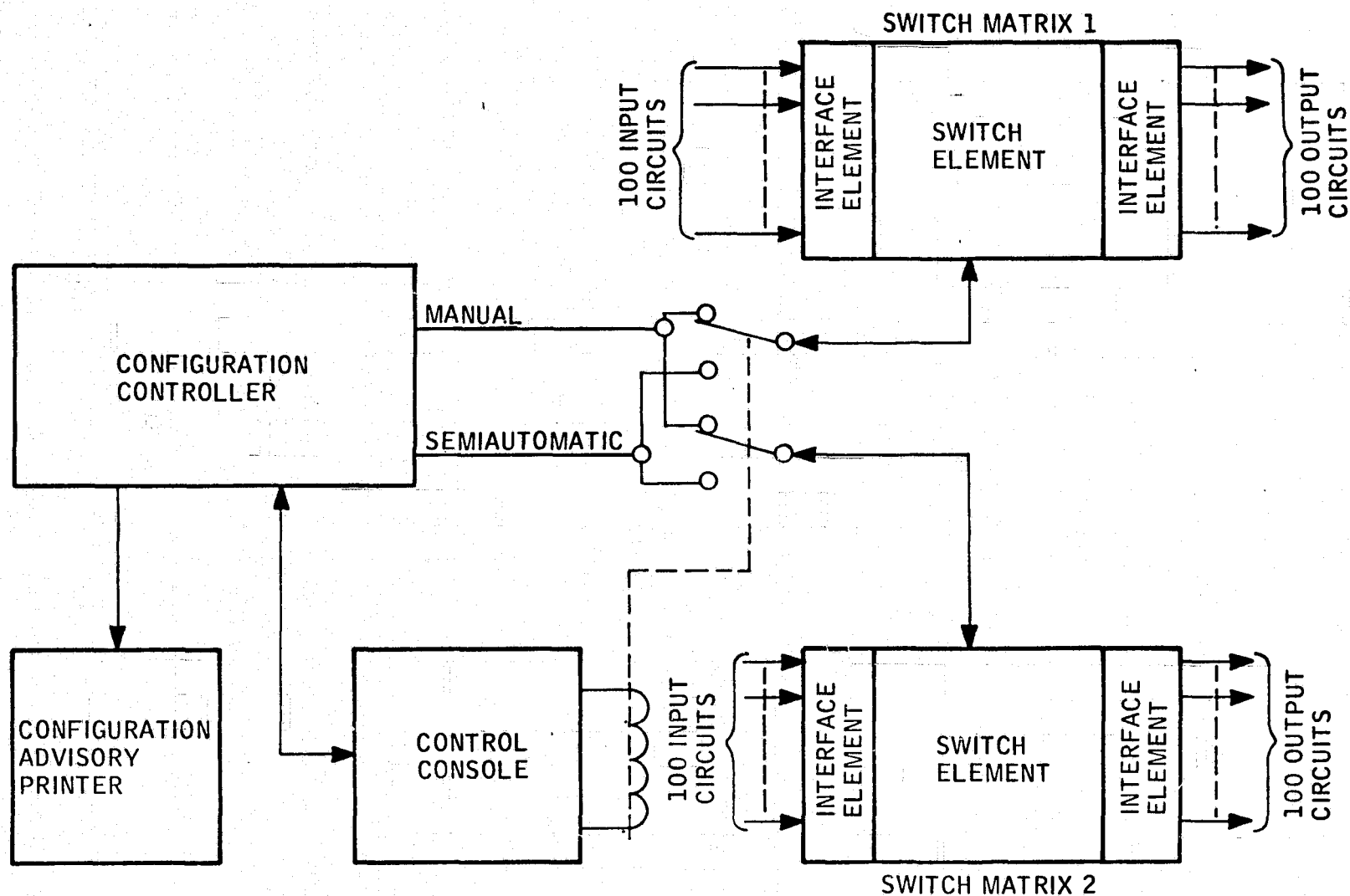


Figure 32 System Configuration Unit

4.3.5.1.3 Configuration Controller. The Configuration Controller shall provide sufficient controls to allow the entry and verification of data paths through the SCU, inject and retrieve test data, localize failures, provide a scan of the matrices, and provide the resulting status to the advisory printer. The Configuration Controller shall be capable of two operational modes, semiautomatic or manual, as selected by the Configuration Control Console. Overall system management shall be provided which is independent of the mode of operations selected by the Configuration Control Console.

4.3.5.1.4 Switch Matrix. Each switch matrix shall consist of a switching element and an interface element. The switching element shall provide the switching of the data lines; the interface element shall convert all data lines to voltage levels compatible with the switching element as well as providing certain control, test and monitoring features.

- a. Switching Element. Each switch matrix shall provide for the connection of any one of 100 inputs to any one or more, up to a maximum of 10, of any 100 outputs. Each input and output shall consist of four levels. Three of these levels shall propagate through the switch matrix from the input to the output; the fourth level shall propagate from the output to the input. The switch matrix shall accomplish the intersections using 3000 input/output intersections (crosspoints). Each switch matrix shall be divided into three groups. Interconnection of one crosspoint in each matrix group shall be required to establish a data path through the switch matrix. The crosspoints in a matrix group shall be individually addressable from the Configuration Controller. To complete a path through a switch matrix, three addresses shall be required. Each address received by a switch matrix shall be encoded and returned to the Configuration Controller for verification before a crosspoint is opened or closed. Redundant switch matrix control lines shall be provided.

4.3.5.1.4 Switch Matrix. (Continued)

- b. Interface Element. The interface element shall provide compatibility between the two switch matrices of the SCU and all data facilities external to and interfacing with the SCU. The interface element for each matrix shall consist of 100 input circuits (ports) mounted on terminator cards and 100 output circuits (ports) mounted on driver cards. Each input and output port shall consist of four levels. The SCU shall allow each external device to utilize one or more of these levels which are arbitrarily designated as data, clock, ready, and Ready-to-Receive (RTR). Each input port shall be capable of accepting three signal levels from the external equipment and shall be capable of transmitting one signal level to the external equipment. Likewise, each output port shall be capable of transmitting three signal levels to and receiving one signal level from the external equipment. There shall be two ports of the same type mounted on an interface card. There shall be three types of functional interface cards and one nonfunctional interface card. The functional interface cards shall be the wide-band MODEM, high-speed MODEM, and 494/360 interface adapter terminator cards and driver cards. The nonfunctional interface card shall be a dummy terminator and driver. The dummy interface card shall have only the necessary circuitry to allow completion of the test data paths. All circuits interfacing between the SCU and the different computer systems shall be termed processor-oriented circuits (POC's). The SCU shall be capable of allowing two or three SDP computer systems to simultaneously support a mission. Consequently, crosspoint configurations defining the data paths through the SCU must simultaneously exist within the SCU for the three system

4.3.5.1.4 Switch Matrix. (Continued)

POC's. Such a crosspoint configuration would allow three sources (each POC) to be connected to a single load (circuits external to SDPC). To allow all three systems to actively process data but allow only one system to drive the load, the interface element shall have provisions for a standby signal which will inhibit all POC's except the online POC's which will be connected to the load. Any of the systems' POC's may be selected to the online position upon command from the control console. Selection of the I/O ports as POC's shall be made via two 300-position pinboards (100 input and 100 output positions per system). The two 300-position pinboards shall supply the standby signal to all ports selected by pins as POC's. The standby signal shall inhibit all three receive levels of the POC input port and the one receive level of the POC output port, and cause the transmitted level of the input port to be constantly active.

Each interface circuit shall consist of four signals, each routed through a different level of the crosspoint switch. Three of the signals are routed in the forward direction, i.e., accompanying data, and the fourth is in the reverse direction. The signal names and functions shall vary depending upon whether the interface carries synchronous or message blocked data. The name and function of each shall be as follows:

<u>DIRECTION</u>	<u>SYNCHRONOUS INTERFACE</u>	<u>MESSAGE BLOCKED INTERFACE</u>
Forward	Data	Data
Forward	Clock	Clock
Forward	Send Request (to activate receiving device)	Ready (frames message to mark beginning and end)

4.3.5.1.4 Switch Matrix. (Continued)

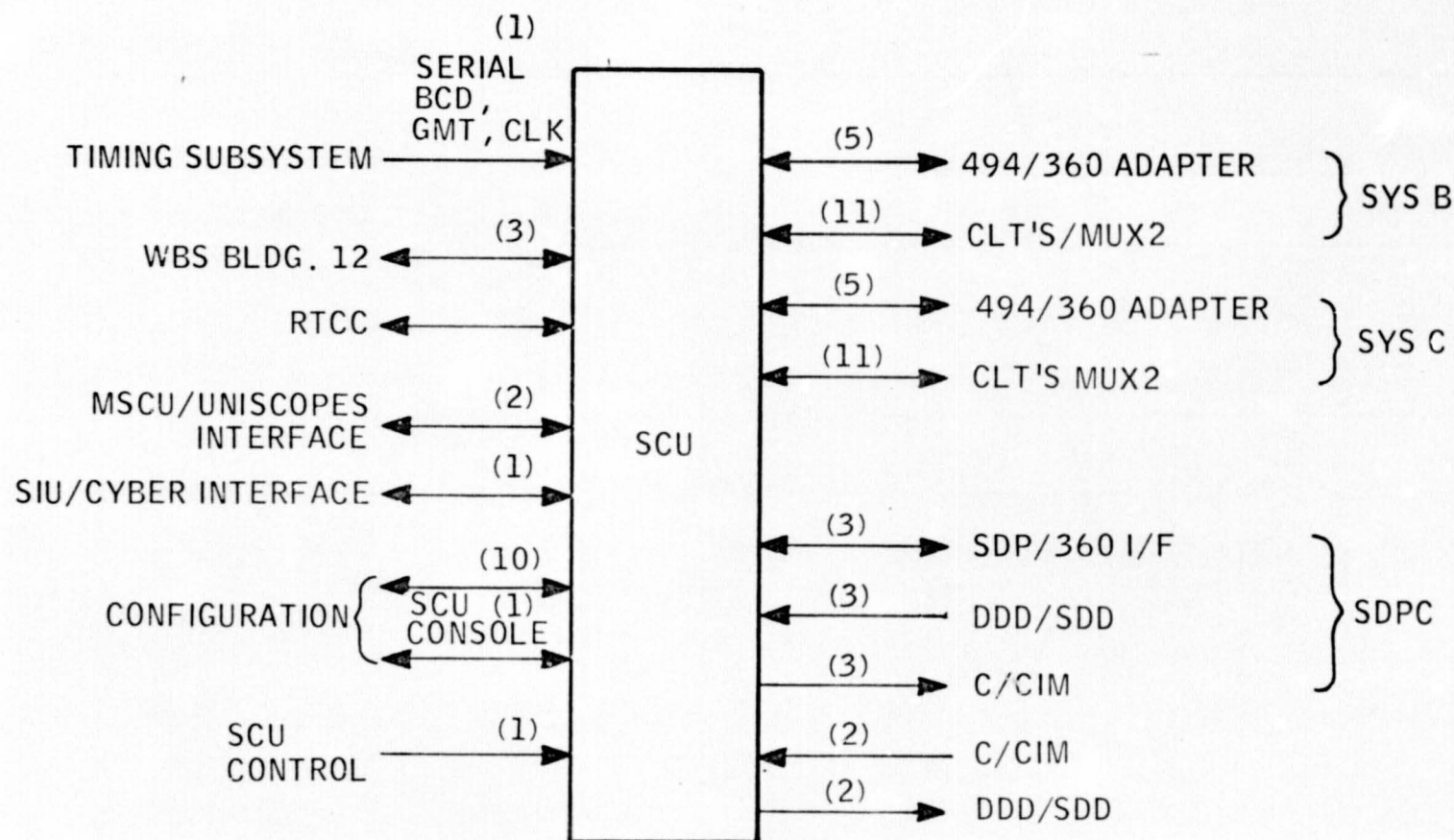
<u>DIRECTION</u>	<u>SYNCHRONOUS INTERFACE</u>	<u>MESSAGE BLOCKED INTERFACE</u>
Reverse	Clear to Send (receiving device conditioned for transmission)	Ready to Receive (re- ceiving device capable of accepting data)

The general interface configuration for the SCU during the OFT time period is shown in figure 33.

4.3.5.2 Systems Selector Unit/System Selector Extension Unit (SSU/SSEU). The SSU/SSEU shall consist of three modified IBM Standard Modular Systems rack and panel modules. Two SSU's shall be joined to form a fixed 2-module unit. The two modules are designated A and B. The third module, an SSEU, shall be labeled C and shall be electrically connected to the SSU.

Module A shall contain Functional Assignment Panels (FAP's) for 360/75 computers A and B; module B shall contain the FAP's for the C (spare), D, and F computers. Module C shall contain a group of IBM wired contact relays that are associated with the mission mode selection functions and one FAP.

4.3.5.2.1 Functional Assignment Panel (FAP). The FAP shall be designed to receive a pluggable patchpanel that contains provisions for jumpering various terminal combinations within the stationary FAP terminal grid. By jumpering the proper points on the patchpanel, the computer subchannel can be interconnected with the desired MCC equipment. When a computer is connected to one of the four buses by the FAP, the connection is common to each FAP (and a test panel). Thus, by jumpering the proper points on a patchpanel, the computer can be connected to any RTCC function.



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Figure 33 SCU OFT Timeframe Interfaces

4.3.5.2.1 Functional Assignment Panel (FAP). (Continued)

Since the assignment of an RTCC computer to one of the basic RTCC functions requires the interconnection of the computer subchannels and MCC equipment in a known manner, it shall be possible to prewire a patchpanel to provide a specific function. Once this patchpanel is wired, it can be inserted into any FAP, and the function for which it was wired assigned to any RTCC computer.

4.3.5.2.2 SSU/SSEU OFT Interfaces. During the OFT time period the SSU/SSEU shall interface the five 360/75's computers with the following equipment:

- SDP's via the SCU
- MOC DDD/SDD
- DSC DDD/SDD
- PDSDD
- Launch and Landing Interface (IP Data)
- Wind Profile Interface
- DCCU
- ALSEP DDDIU
- ALSEP DACIU
- CCMU
- CAJU.

Figure 31 shows the total number of interfaces with the SSU/SSEU which will be involved.

4.3.5.3 360/75 String Switch. The function of 360/75 string switch shall be to interface the five 360/75 MC's and SC's with the following output port interfaces:

- ALSEP
- Printer/card reader punch
- SDL Terminal
- IMS Terminal
- ASP Terminal
- TSO Terminal
- ALSEP/LACIE Terminal
- FEID
- High-speed Shared Disk
- LACIE Disk Pool
- SPP
- DRAFT.

The string switches shall accept interfaces from all 360/75's. Each switch shall have the capability of switching the various output ports to any of the 360/75's input port channels. Only one input port can be connected to any output port at any given time; however, any input port can be connected to any number of output ports as long as the bus load does not exceed its loading limits. The switch(s) can be locally or remotely controlled by operator intervention.

The present 360/75 Computer Complex is using IBM 2914 switches to perform the function of the string switches. It is proposed that these switches be replaced to provide more switching capability

4.3.5.3 360/75 String Switch. (Continued)

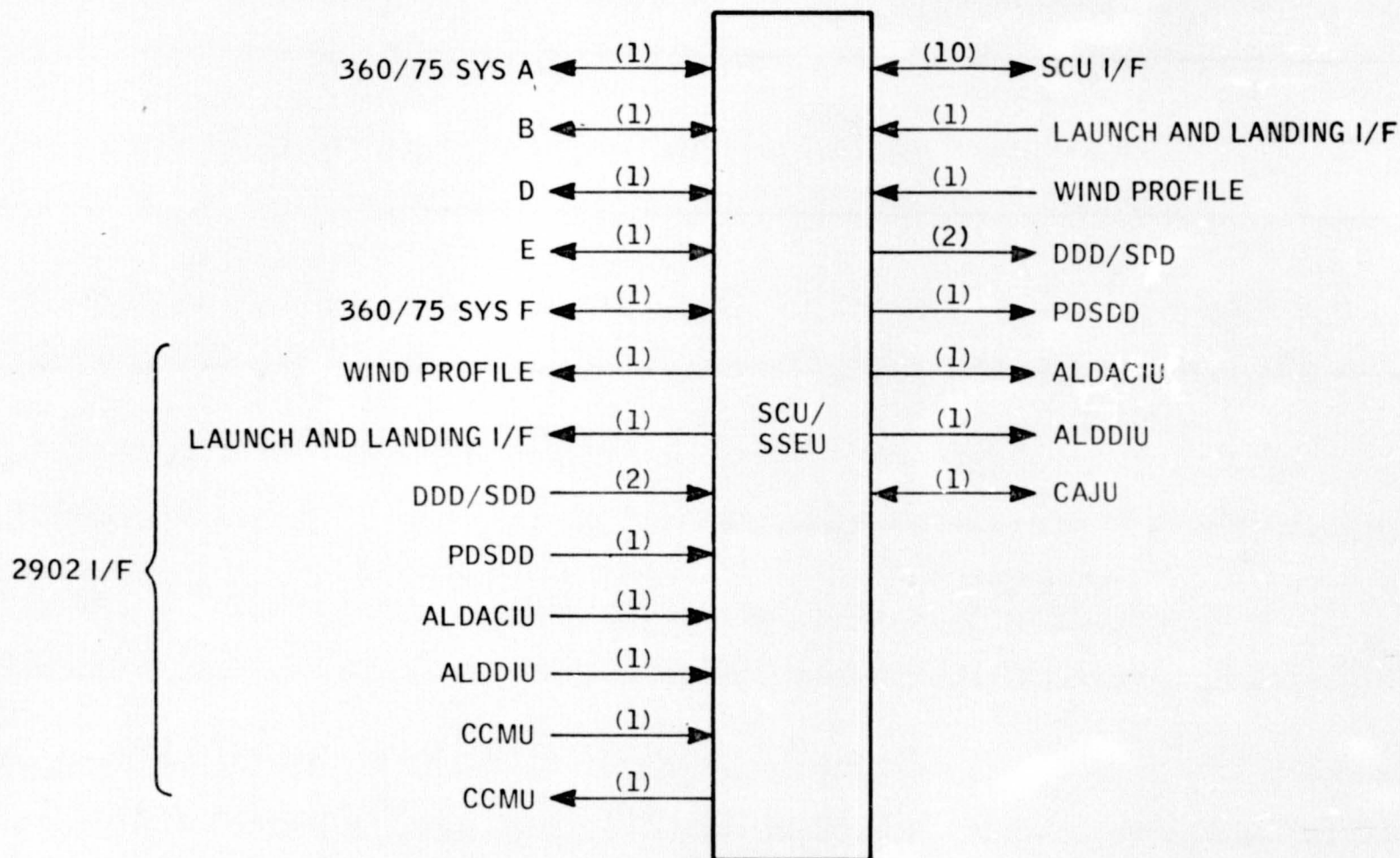
in the 360/75 system. Figure 34 shows how a minimum of three switches to handle all of the 360/75 Complex switching functions.

4.3.6 OFT to OPS Transition. TBS.

4.4 Display and Control System (DCS). The Shuttle OFT DCS shall perform in conjunction with the DCC and the CIS to provide OFT mission and support personnel the capability of requesting and monitoring computer-generated display data. In this capacity, the system shall detect, encode, and transmit operator requests to the computer systems, generate displays in response to these requests, and distribute the display information to the display equipment. Related DCS capabilities shall include the generation and distribution of the primary MCC timing standard, interfaces to video sources external to the MCC, and support of MCC and Payload Operations Control Centers (POCC) command systems.

4.4.1 DCS Capabilities. The DCS shall perform the following major functions:

- Convert computer-generated data into raster-type video displays suitable for distribution to console-mounted TV
- Convert computer-generated data into large screen plotting and X-Y plotboard type displays suitable for group viewing
- Convert computer-generated event data into discrete event data suitable for acceptance by console modules, trajectory analog recorders, the TS and the plotting displays control logic
- Convert computer-generated data into analog and bilevel event data suitable for display on stripchart recorders
- Offline convert of computer-generated, mission-related, data into high resolution film images



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Figure 34 SSU/SSEU OFT Timeframe Interfaces

4.4.1 DCS Capabilities. (Continued)

- Provide the physical housing for the majority of control and display end devices required for direct operator interface with the Shuttle DCC
- Provide switching and monitoring of the video subsystems
- Provide timing signals to other major systems and subsystems
- Provide conversion of command panel switch inputs into data suitable for DCC input
- Provide hardcopy of TV displays
- Provide distribution of hardcopy material throughout the MCC.

4.4.2 DCS Major Components. The DCS shall comprise the following major subsystems:

- Digital Television Subsystem
- Television and Video Switching Distribution Equipment Subsystem
- Video Hardcopy Equipment Subsystem
- Group Display Subsystem
- Discrete Display Subsystem
- Analog Event Subsystem
- Console Subsystem
- Timing Subsystem
- Display Select Computer Input Multiplexer Subsystem
- Command Computer Input Multiplexer Subsystem
- Computer Output Microfilm Subsystem
- Pneumatic Tube Subsystem.

4.4.2.1 Digital Television Subsystem (DTS). The DTS shall provide the capability to convert Shuttle DCC computer language data into dynamic raster-type video displays containing both alphanumeric and graphic information. The DTS shall continually refresh the last information received from the DCC until the display is either deselected by the user or updated by the DCC. The displays generated by the DTS are made available for viewing, when selected by the user, within the MCC on console and/or overhead TV monitors. The DCS shall also provide the capability for the initial allocation of DTE resources to the DCC computers, and for the continuing near real-time reallocation of those resources in accordance with changing support requirements and priorities. The DTS shall consist of the following major components:

- Digital Television Equipment (DTE)
- Digital Television Equipment Cluster Control Unit (DCCU)
- Video Switching Matrix Buffer Multiplexer (VSMBM).

4.4.2.1.1 Digital Television Equipment. The total MCC DTE shall consist of 10 clusters of 8 DTE channels each. The 80 DTE channels shall be capable of interfacing with 8 DCC computers as enabled by the DCCU. Eight clusters (64 television channels) shall provide video to the VSM for MCC distribution, and two clusters (16 channels) shall provide video to the auxiliary video switching matrix (AVSM) for special application use. For purposes of system definition all capabilities of the DTE are discussed in this section. It should be noted, however, that during the OFT timeframe the DTE shall not provide DTE resident backgrounds or operate in the 48-bit mode. All DTE background displays shall be DCC resident. The DTE disk shall be used exclusively for DTE diagnostic routines. Additionally, the DCC/DTE word format shall be 36-bit.

4.4.2.1.1 Digital Television Equipment. (Continued)

- a. DTE Functions. Each DTE Cluster shall accept computer language data from the DCC. This data, either dynamic or background, shall be converted to alphanumeric characters (five selectable sizes), symbols (five selectable sizes), and vectors as required to generate the requested video information contained in any selected display (video) format. Each channel within a cluster shall be capable of the following throughput processing:
- Accepting DCC inputs and assembling them in a computer language memory (CLM) (including accessing a background storage device, when required)
 - Scaling, translating, and reformatting the data from the DCC coordinate system (when required)
 - Generating raster-type display data and assembling it in a display language memory (DLM)
 - Transferring the display data from the Display Language Memory to the refresh memories (RM's)
 - Transferring the display data from the RM's to the TVSS in a composite or noncomposite form
 - Providing video outputs to the DRAFT video printer
 - Transferring video switching data, received through the DCC interface, to the VSMBM for subsequent assignment of individual DTE channel video outputs to console monitors.
- b. DTE Throughput Processing Requirements. The DTE shall be capable of updating all eight channels of a cluster a minimum of once each second. An update cycle for a channel shall be defined as the time

4.4.2.1.1 Digital Television Equipment. (Continued)

required to extract data from the CLM, generate the corresponding vectors or characters and display them on a CRT. Whenever less than worst-case conditions (type and volume of data) are encountered in the processing cycle for any channel, the processing time shall be the minimum required to generate that particular display; i.e., the processing cycle for any channel shall be initiated by completion of the processing cycle for the previous channel. Thus, the update rate shall increase as data volume decreases; if only one channel is active, it shall be updated by every DCC input. Initialization time for the cluster shall be determined by the number of channels receiving simultaneous inputs, and the type of data input (one or a combination of the three types). Worst-case initialization times are required for Mode I (all backgrounds are DTE-resident backgrounds) and Mode II (all backgrounds are DCC resident backgrounds). Analysis of the two modes shall assume the following:

- (1) A channel sequencer scans through the CLM on a channel-by-channel basis. A channel is processed only if it has been updated since the last DTE processing cycle.
- (2) A DTE-resident background display, if completely assembled in the background storage area of the CLM for a particular channel at the start of the scan cycle for the channel, shall have priority over any dynamic data that may also be available for that channel.

Throughput processing times shall be determined by combinations of input rates, data types, and data volume. Input rates for a cluster shall vary from those for single channel data up to eight simultaneous channel inputs, one for each channel. Data

4.4.2.1.1 Digital Television Equipment. (Continued)

shall be one of three classes: dynamic data (character or vector), DTE-resident background data (character or vector) and DCC-resident background data (character or vector). The volume of data input for a single channel shall vary from a minimum of 1 word (a CSF Command) to a maximum of 1024 words for dynamic updates or DCC-resident background, or 1536 words for a DTE-resident background.

- c. Dynamic Data Generation. The DTE shall be capable of generating characters and vectors at the rates specified in tables 1 and 2. Rates are shown in characters (or vectors) per second per cluster. It is not required that both the worst-case number of characters and vectors be fully generated for any cluster in 1 second; i.e., display updates can contain all character data, all vector data, or combinations of both. However, the DTE shall be capable of generating those portions of an update comprising characters or vectors at their respective worst-case rates.

- (1) Character Generation. The DTE shall be capable of generating any of five character sizes at the rates specified in table 1. The characters per second per cluster calculations are based on the total available processing time per second per cluster; i.e., 1 second minus eight (one per channel) display language core-to-refresh memory transfer times.

- (2) Vector Generation. Vector generation capability shall be provided for either of two vector types, those with slopes less than 45 degrees, and those with slopes greater than or equal to 45 degrees. Based on the requirement that all eight channels be updated at least once a

TABLE 1
CHARACTER GENERATION REQUIREMENTS

CHARACTER SIZE (BITS × LINE PAIRS)	GENERATION TIME (SECONDS)	CHARACTERS PER SECOND PER CLUSTER
5 × 7	16.9×10^{-6}	50.0×10^3
7 × 9	19.5×10^{-6}	43.3×10^3
9 × 12	23.4×10^{-6}	36.7×10^3
10 × 14	26.0×10^{-6}	33.3×10^3
14 × 18	31.2×10^{-6}	27.0×10^3

TABLE 2
VECTOR GENERATION REQUIREMENTS

VECTOR LENGTH (POINTS)	GENERATION TIME (MICROSECONDS)	VECTORS PER SECOND PER CLUSTER
100	86.0	10.00×10^3
200	169.2	5.12×10^3
300	255.2	3.38×10^3
400	331.2	2.60×10^3
500	406.2	2.12×10^3
600	492.2	1.75×10^3

4.4.2.1.1 Digital Television Equipment. (Continued)

second, the DTE shall be capable of vector generation rates as shown in table 2. The vectors per second per cluster calculations are based on the total available processing time per second per cluster.

- d. Cluster Identification. The DTE shall decode and examine the operation code of each word transmitted by the DCC. The first word in each message shall be a command word. If the command is a 36-bit DTE command or background command, or a 48-bit dynamic control, background control or background request word, the DTE shall decode the cluster select code. Subsequent data in the message shall be accepted by the selected cluster until the message is terminated. If the command is a 36-bit CSF word, the DTE shall examine the TV channel ID and shall make the necessary conversion to determine the intended cluster for the slide/MSK data. The VSM portion of a CSF word will be passed on to the VSMBM by any cluster having its VSM Enable/Disable switch in the ENABLE position. The TV channel assignments for each cluster shall be manually changeable with switches or plug-in logic cards. The cluster channel assignments shall be sets of 8 consecutive TV channels, chosen from the 12 sets below:

- 1 (1_8) - 8 (10_8) - VSM
- 9 (11_8) - 16 (20_8) - VSM
- 17 (21_8) - 24 (30_8) - VSM
- 25 (31_8) - 32 (40_8) - VSM
- 33 (41_8) - 40 (50_8) - VSM

4.4.2.1.1 Digital Television Equipment. (Continued)

- 41 (51_8) - 48 (60_8) - VSM
 - 49 (61_8) - 56 (70_8) - VSM
 - 57 (71_8) - 64 (100_8) - VSM
 - 65 (101_8) - 72 (110_8) - Spare Addresses
 - 73 (111_8) - 80 (120_8) - Spare Addresses
 - 81 (121_8) - 88 (130_8) - AVSM
 - 89 (131_8) - 96 (140_8) - AVSM.
- e. Format Compatibility. The DTE shall accept multiples of either five bytes for the 36-bit format, or six bytes for the 48-bit data format. In 36-bit mode, the four MSB's of the first byte of each 5-byte/40-bit word received from the byte serial adapter (BSA) shall be disregarded. The mode of operation shall be switch-selectable on a cluster-by-cluster basis, and the cluster hardware shall be completely reinitialized when switching modes. The DTE shall verify that the total number of bytes received from the DCC in a single message is divisible by five in the 36-bit mode, and is divisible by six in the 48-bit mode. A command error is sent to the DCC if the correct division is not verified.
- f. DCC-DTE Data Transfer Rates. Each DCC-DTE interface shall be capable of accepting data at a total rate of up to 400 kb/s. Each cluster shall be capable of accepting data from one or more interfaces at a compound input rate greater than 800 kb/s. The DCC may be prevented from inputting to a single channel for up to 2.66 ms if the DTE is involved with input buffer data management of the channel.

4.4.2.1.1 Digital Television Equipment. (Continued)

- g. Error Detection. Several types of errors shall be detected by the DTE, including DCC/DTE parity errors, addressing errors, data content errors, internal processing errors, and Background Storage Unit/Display Cluster transfer errors.
- h. DTE Output Video Requirements. The DTE raster, or frame, shall consist of two fields, one containing all of the even-numbered lines and the other containing all of the odd-numbered lines. The DTE shall employ the repeat-field mode whereby the visible information contained in the second or even field shall be identical to and a repetition of the visible information contained in the first or odd field.
- i. DTE Cluster Functional Description. Each DTE cluster shall be divided into discrete areas that perform specific functions. These discrete areas shall be interconnected, combining the specific functions of each area into one overall function of converting computer generated digital data into a TV display. The following are the major discrete areas of a DTE cluster:
 - Input/Output Cabinet
 - Data Processing Cabinet
 - Refresh Memory Cabinet
 - Display Cluster Diagnostic Unit
 - Disk Drive Unit.

4.4.2.1.1 Digital Television Equipment. (Continued)

- (1) Input/Output Cabinet. The major components of the I/O cabinet are the Input Interface Module (IIM) drawer and the CLM drawer. The I/O cabinet shall also contain the following functions:
 - (a) Input Interface Module (IIM). The IIM shall provide the DTE interface with the DCC (eight computers), the DCCU, and the VSMBM.
 - (b) Memory Assignment Control (MAC). The MAC shall control access to the CLM.
 - (c) Channel Sequencer. The channel sequencer shall sequence the data processor to a channel containing new data.
 - (d) Editor. The editor shall edit and organize new data stored in the CLM while transferring it from the CLM input buffer to the CLM processing buffer.
 - (e) Computer Language Memory (CLM). The CLM shall store new data, the conversion and font tables, and shall provide working storage for the DCC. The CLM shall have a capacity of 16,384 words of 48 bits each with a memory full cycle time of 1.3 μ s.
- (2) Data Processing Cabinet. The Data Processing Cabinet shall contain the Data Processing Logic (DPL) drawer and the DLM. The cabinet shall contain the following major logic functions:
 - (a) Character/Vector Generator. The character/vector generator shall convert CLM data into characters and vectors for storage in the DLM.

4.4.2.1.1 Digital Television Equipment. (Continued)

- (b) Background Request Control Logic (BRCL). The BRCL shall cycle through the background buffer area of the CLM seeking background requests. If a request is found, the BRCL shall initiate a transfer of the requested background data from the disk memory to the CLM. Once the transfer is completed, the character/vector generator shall convert the data and transfer it to the DLM for storage.
- (c) Display Language Memory. The DLM shall accept data from the character/vector generator for storage in display language for later transfer to the RM. The DLM shall have a capacity of 8,192 words of 48 bits each with a memory full cycle time of 1.3 μ s.
- (3) Refresh Memory Cabinet. The RM cabinet shall contain 16 RM's. Eight RM's shall contain the dynamic data for eight channels and the other eight shall contain the background data for eight channels. The format generated by the character/vector generator and stored in the DLM shall be transferred to one of the channel memory modules in the RM cabinet. Video generation logic in the module shall provide a continuous refresh of this data to the video outputs 60 times a second. Each RM shall contain 4096 words of 64 bits each.
- (4) Display Cluster Diagnostic Unit. The DCDU shall contain the DCDU control logic drawer and the memory exerciser drawer. The cabinet shall contain the following major logic functions:

4.4.2.1.1 Digital Television Equipment (Continued)

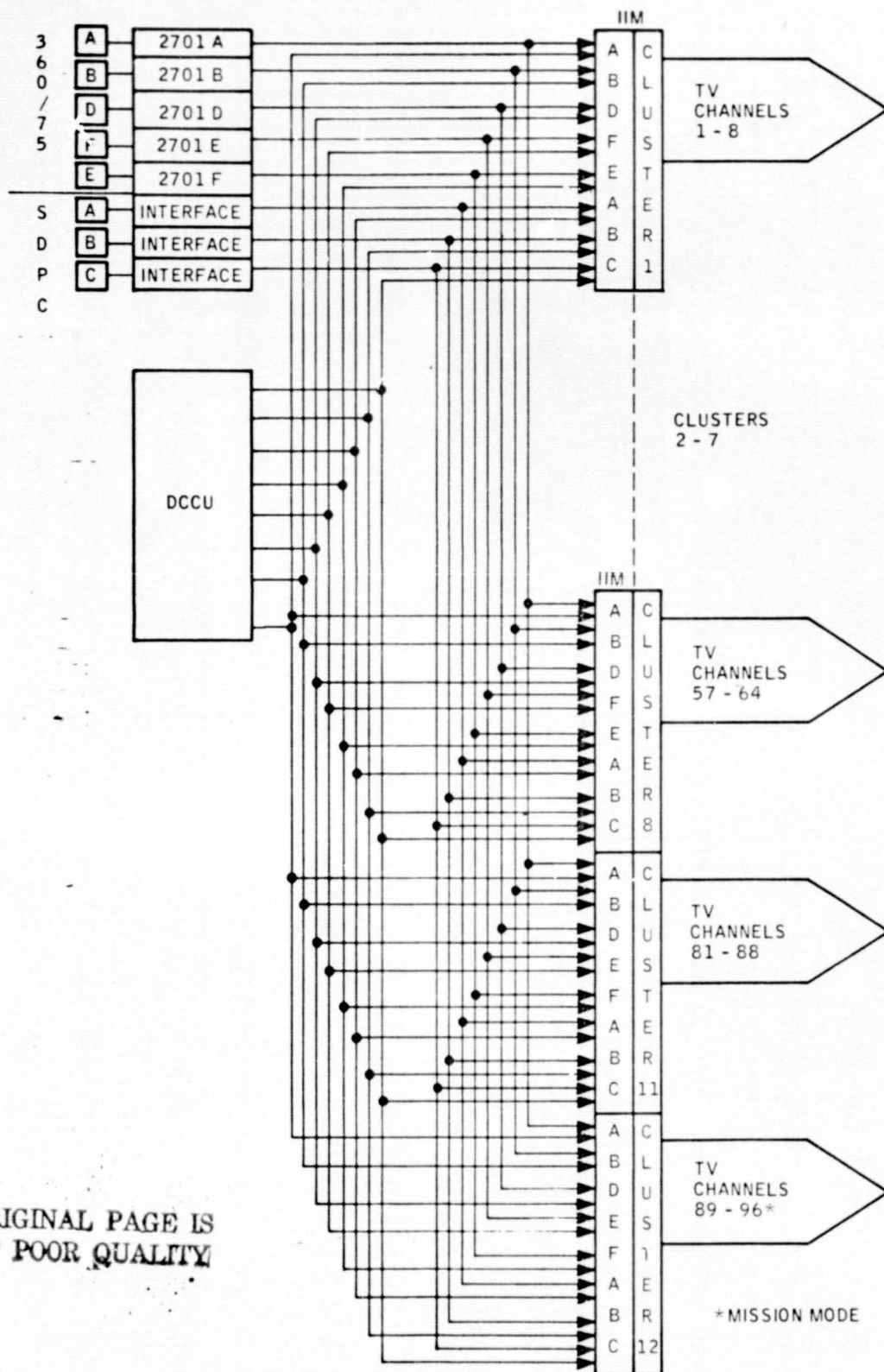
- (a) DCDU Control Logic. This circuit shall provide the interface between the DCDU and the display processor and the I/O cabinets; the disk control logic and the disk drive unit.
 - (b) Memory Exerciser Logic. This circuit shall provide the interface logic for the paper tape reader, and shall provide test patterns for testing all memories contained in the cluster. The test patterns shall originate from paper tape, the disk, or by manual entry from the operations panel.
 - (c) Operations Panel. The operation panel shall provide control and status indication of all selectable cluster functions.
 - (d) Tape Reader Panel. This panel shall provide the capability of entering data tables and test data into the CLM or into the IIM's through the DCC simulator.
 - (e) TV Monitor Panel. The TV monitor panel shall provide capability for visual observation of the video output of any two refresh memories simultaneously.
- (5) Disk Drive Unit. One disk drive unit shall be provided for each DTE cluster. This unit shall function as a diagnostic data storage unit and shall be a movable head, removable disk pack disk file, electrically and physically compatible with an IBM 2311 Disk Drive. The data recording formats on the disk shall be in accordance with SISO-TR446, *DTE Background Disk Programming Requirements*. The DCC shall be able to

4.4.2.1.1 Digital Television Equipment. (Continued)

input background data to the background storage unit for disk storage via the normal IIM input interface. The words per message to be input for storage on the disk shall be limited to 1.5K by the DTE.

4.4.2.1.2 DTE Cluster Control Unit (DCCU). The DCCU shall control the allocation of DTE resources to computer data sources in the MCC. The DCCU shall be capable of providing for allocation control of 80 DTE TV channels (10 8-channel clusters) and 8 computers. A detailed description of the DCCU equipment performance is provided in SISO Specification SE-09588, *DTE Cluster Control Unit Performance Specification*.

- a. Functional Requirements. The DCCU shall provide functional configuration control of the DCC/DTE data interface. This interface shall comprise eight independent, hardwired data paths, each originating in a DCC computer and terminating in a dedicated input part in every DTE cluster. It shall utilize a daisy-chain bus terminating technique to ensure that the data on any single DCC/DTE data path appears as an input to all clusters. The DCCU shall govern the acceptance or rejection of these inputs (by DTE) by issuance of enable or disable signals to each DTE cluster via DCCU/DTE control interfaces (see figure 35). The generation and issuance of these signals shall comprise the DCCU allocation function; the DCC/DTE interface configuration resulting from the status of these signals shall reflect one of the three basic allocation operations provided by the DCCU's primary cluster allocation, selectover allocation, and restart allocation.



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Figure 35 DCCU/DTE Control Block Diagram

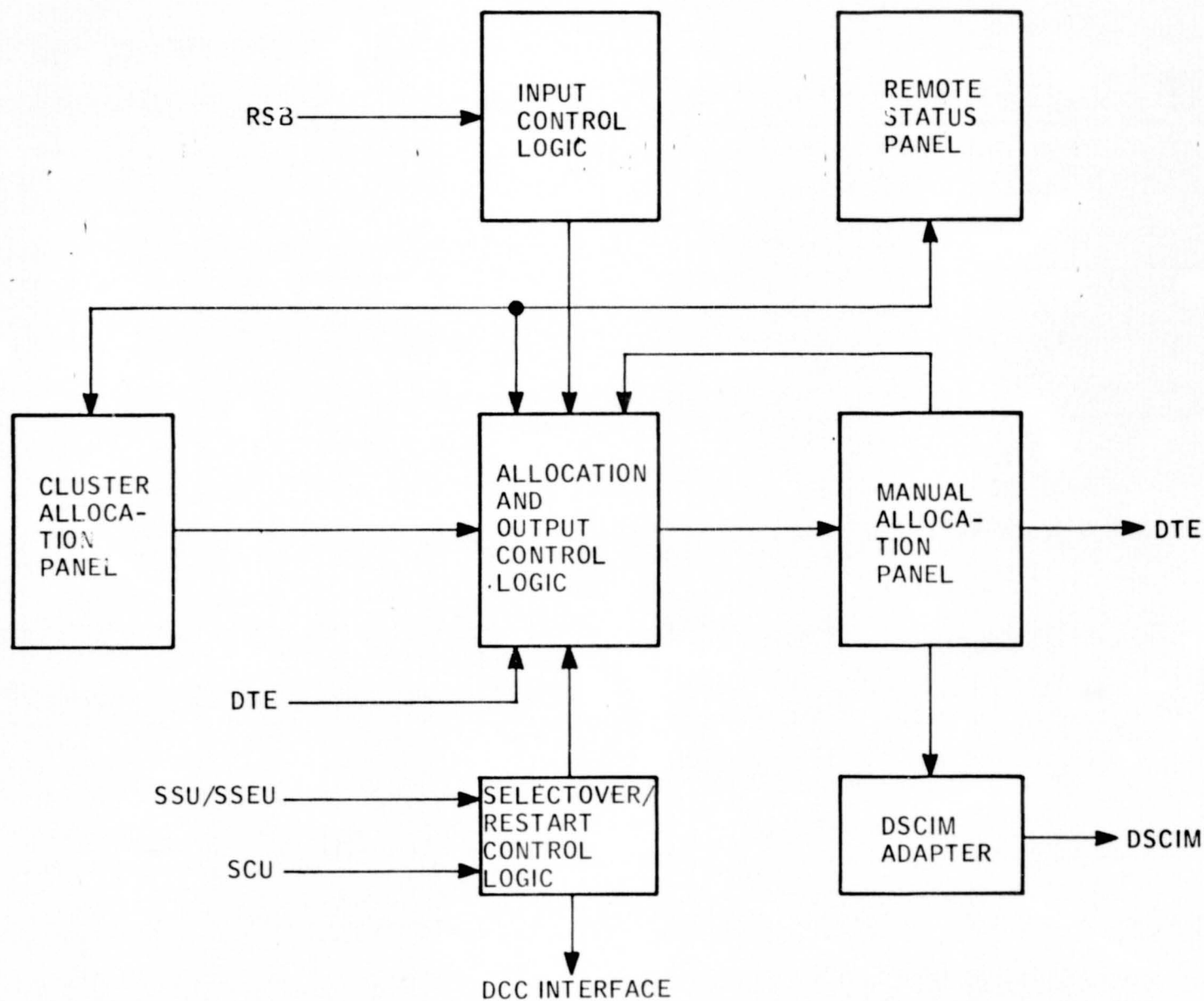
4.4.2.1.2 DTE Cluster Control Unit (DCCU). (Continued)

b. DCCU Major Components. The DCCU shall comprise the following major components (see figure 36).

(1) DCCU Control Console. Control and status indication of DTE cluster allocations shall be provided through the following:

(a) Cluster Allocation Panel. Pushbutton and indicator switches that shall indicate computer designation, cluster allocations and restrictions, status change, multiple computer restrictions, lamp test, and selectover test.

(b) Manual Allocation Panel. This panel shall provide separate toggle switches for enable/disable outputs to eight computer interfaces in each DTE cluster. Each switch shall be operated independently of the others and shall provide a locking lever to prevent accidental selection. The panel shall be provided with a locking cover. The DCCU shall provide a backup manual allocation panel to perform allocation (or reallocation; if required to reflect restart or selectover) in the event of DCCU logic or circuit failure. This shall be provided in lieu of DCCU logic redundancy. Also parallel, diode-isolated, load-sharing power supplies shall be provided. Each shall be connected to a separate external source (A and B power busses), and each shall be capable of carrying full load requirements for the logic and manual allocation panel.



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Figure 36 DCCU Functional Block Diagram

4.4.2.1.2 DTE Cluster Control Unit (DCCU). (Continued)

- (2) DCCU Remote Status Console. This console shall provide an indication of DTE resource allocation and configuration selected by the DCCU control console. Its remote status panel shall be similar to cluster allocation panel, but shall be composed of remoted indicators only.
 - (3) DCCU Equipment Cabinet. This cabinet shall contain input control logic, allocation and output control logic, selectover control logic, and CIM interface adapter logic.
- c. Cluster Allocation Requirements. The DCCU shall control the acceptance or rejection of the computer data appearing at the DTE input interfaces by providing a cluster allocation function. This function shall be defined as the generation and issuance of enable (acceptance) or disable (rejection) control signals from the DCCU to the DTE clusters. Each signal shall govern the response of an associated IIM to its computer inputs. Cluster allocation shall permit assignment of single cluster to a single computer or, if required, assignment of a single cluster to multiple computers. Procedurally, however, those clusters assigned to a MOC or DSC in a mission environment shall not be shared by any other computer and shall require protection from such an occurrence; the DCCU shall provide this in the form of a selectable mode of operation in which any reallocation or deselection of mission-supporting clusters shall be inhibited.
- d. Selectover Requirements. In a mission environment, a MOC/DSC pair shall supply DTE display data for the Mission Operations Control Room (MOCR) and Auxiliary Display Equipment Group (ADEG), respectively, on the mission floor to which the pair is assigned. Since both computers in the pair output

4.4.2.1.2 DTE Cluster Control Unit (DCCU). (Continued)

identical data, these correlations must be established through cluster allocation by enabling those connected to the ADEG to accept only DSC data. To ensure the more critical MOCR users a valid data source in the event of MOC failure, the DCCU shall provide a selectover function, which when initiated, shall automatically recondition the MOCR clusters to accept data only from the original DSC, which shall then become the MOC, and conversely, permit the ADEG clusters to accept data only from the original MOC, which shall then become the DSC. The DCCU shall be capable of providing for selectover capability from two computer systems (360 and SDPC). The selectover function is further defined for the MOC operational configurations as follows.

- (1) Single Mission Selectover. When conditioned for selectover by either of two R/S modules in the DCC, the DCCU shall perform the selectover operation without affecting allocations to any existing nonmission applications.
 - (2) Pseudo MOC/DSC Selectover. When supporting nonmission functions not requiring the MOCR/ADEG concept, any desired dynamic/standby computer pairs (pseudo MOC/DSC) shall be provided the selectover function if that function is requested from the R/S modules.
- e. Restart Requirements. The nominal procedure following a selectover due to MOC failure shall be to designate a new DSC from the R/S modules. This operation, which is one mode of the existing R/S module restart function, shall initiate a corresponding restart in the DCCU, which shall cause those clusters allocated to the previous DSC to automatically be reassigned to the new DSC upon valid receipt of its identification. DCCU restart shall not be restricted to the nominal mode defined in the preceding paragraph; any valid MOC or DSC entry to the DCCU shall cause the existing MOC or DSC allocations to be reassigned to the newly designated computers.

4.4.2.1.3 Video Switching Matrix Buffer Multiplexer (VSMBM).
The VSMBM shall accept video switching requests from the DTE and the Display Select Computer Input Multiplexer (DSCIM) and shall control the transfer of these requests to both the VSM and the AVSM. In addition, the VSMBM shall accept function oriented TV saturation data inputs from the DTE and provide outputs suitable for interface with the Telemetry Event Drivers (TED's) for driving the console mounted amber or red TV saturation indicators, and also for driving LED readouts on the TV Channel Status Module (TCSM).

- a. Functional Requirements. The VSMBM shall satisfy the following operational requirements.
 - (1) The VSMBM shall provide 10 separate input interfaces. One serial interface shall be compatible with DSCIM requirements; eight parallel interfaces shall be compatible with the DTE requirements; and one (spare) shall be a parallel interface.
 - (2) The VSMBM shall provide storage and gating for video switching requests from all 10 input interfaces.
 - (3) The VSMBM shall provide four output interfaces including the VSM, AVSM, TED and TV channel status module.
- b. VSMBM Input/Output Requirements. The following paragraphs describe the VSMBM I/O characteristics.
 - (1) DSCIM Interface. The DSCIM input to the VSMBM shall be a bit serial interface under the control of the DSCIM. The data transferred shall include TV channel ID, console ID, and monitor ID.

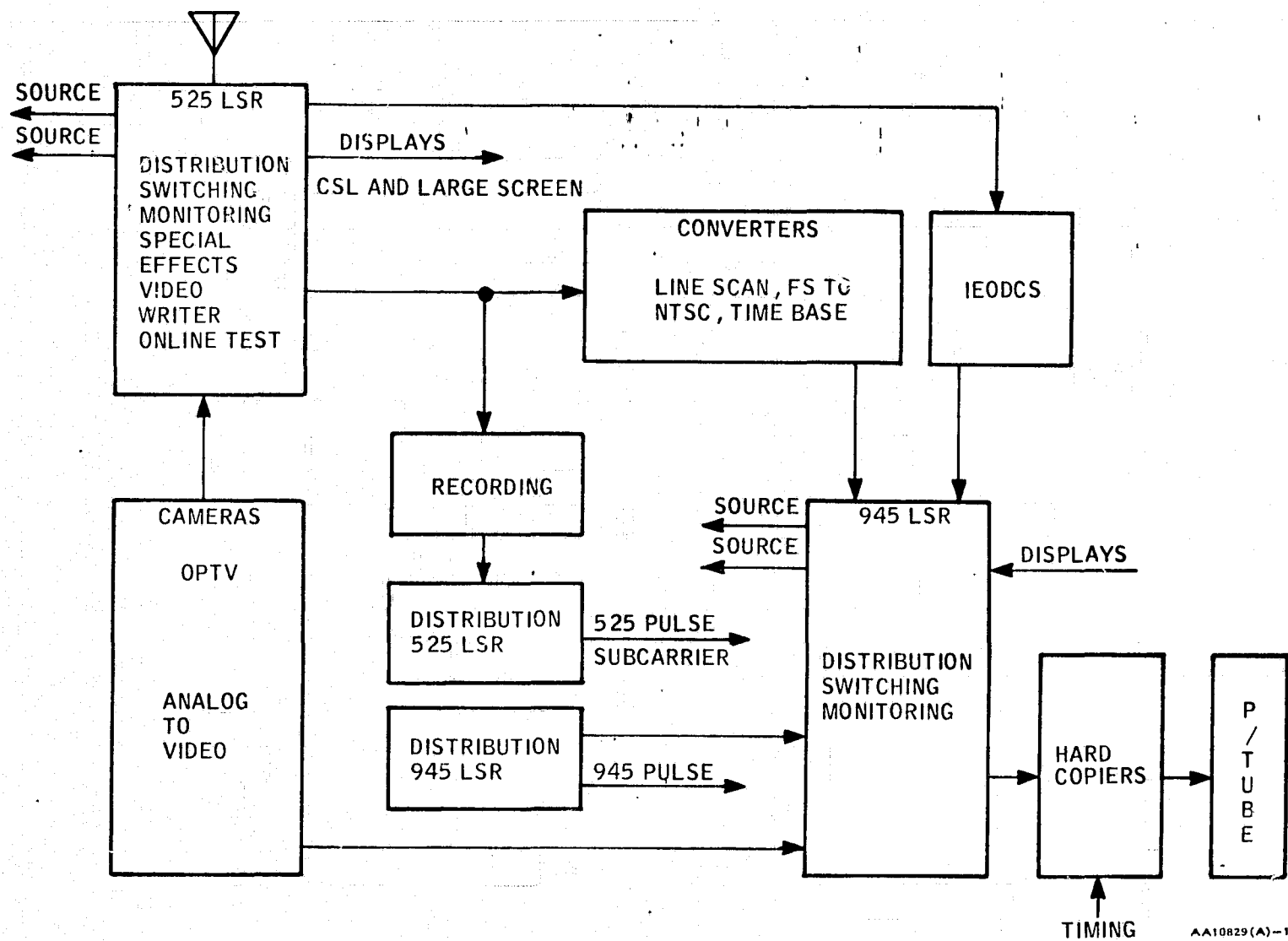
4.4.2.1.3 Video Switching Matrix Buffer Multiplexer (VSMBM).
(Continued)

- (2) DTE Interface. Each DTE input to the VSMBM shall be a word parallel interface operating on a demand-response basis initiated by each individual DTE. Data transferred shall include TV channel ID, destination address, and monitor ID. In addition, a TV saturation word shall be transferred to the VSMBM via the DTE. This word shall include a function ID, the number of TV channels assigned or remaining (for the particular function), and amber or red saturation indicator illumination data.
- (3) VSMBM/(VSM/AVSM) Interfaces. The VSMBM (VSM/AVSM) interfaces each shall consist of 19 parallel data lines, one strobe line, and two return lines. Data transferred shall include TV channel ID, destination console ID, and monitor ID.
- (4) VSMBM/TED Interface. The VSMBM/TED interface shall consist of 126 parallel lines including 64 lines for red saturation (4 lines for each of the 16 Shuttle functions); 64 lines for amber saturation (4 lines for each of the 16 Shuttle functions), and 2 TED return lines (one line for red saturation and one line for amber saturation). Although the VSMBM provides for the decode and drive capability for amber saturation, no OFT requirement exists to perform this function.
- (5) VSMBM/TCSM Interface. The VSMBM/TCSM interface shall consist of 40 parallel lines including 16 lines for (number of TV channels) assigned strobes (one line per Shuttle function), 16 lines for (number of TV channels) remaining strobes (one line per function), and 8 lines for assigned and remaining data.

4.4.2.2 Television and Video Switching Distribution Subsystem. The TVSS is a multifunction information display and recording system. The TV equipment group shall be configured with two line scan rate (LSR) systems. Standard resolution shall be 525 LSR and high resolution 945 LSR. Synchronizing pulses required for the 945 LSR shall be generated in the TS from an atomic standard. Distribution of synchronization pulses and video shall be provided by the TV equipment group. The 525-LSR synchronization pulse clock shall be generated from a rubidium standard within the 525-LSR system and with a 525-LSR video within the TV equipment group. In addition to MCC-generated video, the TVSS interfaces, processes, and enhances spacecraft video signals and distributes them to external users (see figure 37).

4.4.2.2.1 Major TV Components. The TV equipment group shall perform the following.

- Video generation
- Standard conversion
- Pulse distribution
- Large screen TV projection
- Video distribution
- Sequential color conversion
- Video display
- Horizontal and subcarrier phaselocking
- Video recording
- Frame synchronization



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Figure 37 OFT D/C TV Subsystem

4.4.2.2.1 Major TV Components. (Continued)

- Video processing and enhancement
- Video switching
- Hardcopy generation.

4.4.2.2.2 Video Switching and Distribution. Video switching shall be accomplished using the existing switching system. Currently the number of accessible, switchable video sources and the number of discrete users is limited by the VSM to 80 inputs and 160 outputs per floor, with an additional 20 input by 20 output AVSM. An additional 160 outputs shall be obtained by paralleling the two VSM's. Distribution of video and timing pulses shall be accomplished by the use of video and pulse amplifiers that are designed to accept a single loop-through or terminated source and provide from one to three identical outputs at 75-ohm source impedance, with synchronization add capability provided. The final video and distribution design shall be determined at a later date.

4.4.2.2.3 TV Reception (RF System). The TV RF System shall be capable of accepting inputs "off the air" of local TV commercial broadcast stations. The amplifier system associated with this system shall be configured to accept commercial channels 2, 11, 13, and 8. In addition to the "off the air" signals the RF system shall have the capability of accepting locally (Bldg. 30) generated 525-LSR signals that are converted to RF and applied to the system as TV channels 4 and 6. Both video and audio shall be available on all channels (with the exception of 4 and 6), as output signals. The RF signals channels 2, 4, 6, 8, 11, and 13 shall be distributed throughout Bldg. 30 to specified areas via a coaxial transmission line with appropriate tap-offs at the designated locations. Standard commercial TV receivers are connected at these line drop taps for viewing by operational personnel.

4.4.2.2.4 TV Conversion Equipment. The TV conversion equipment shall include the LSR converter, FS-to-NTSC converter, and time base converter [Digital Coherent Video Synchronizer (DCVS)].

- a. LSR Converters. The LSR converters shall perform the change from one scan rate to another (945 to 525 or 525 to 945) through a camera and monitor combination for each converter. The video information shall be presented on a monitor at one scan rate and picked up by a camera operating at the scan rate of the display monitors. This arrangement provides an economical scan rate conversion with some loss in resolution.
- b. FS-to-NTSC Color Converter. The 525-line system shall provide for the conversion of spacecraft sequential color video to an NTSC format and simultaneously record this information for OFT editing, playback, and archive. The time base of the incoming FS signal shall be corrected to the Bldg. 30 sync standards by a Tape Loop or Solid State Memory Time Base System before processing into NTSC format. The basic hardware in the FS/NTSC converter shall be a rotating magnetic disk with three flying heads that input through switchable 1/2-line delay lines. The control logic shall be arranged so that recording and playback occur in an output sequence compatible with NTSC encoder requirements. The simultaneous red, green, blue (RGB) signal shall be routed to an encoder where chrominance and burst are added to provide the complete color encoded signal. The FS-to-NTSC color converter shall satisfactorily support all known OFT requirements.
- c. Time Base Converter. The DCVS shall be a self-contained video processing unit consisting of analog and digital circuit assemblies and all necessary power supplies. The primary function of the DCVS is to accept any EIA, NTSC, or field sequential 525-LSR nonsynchronous video signal and output a compatible video signal which is synchronous to the

4.4.2.2.4 TV Conversion Equipment. (Continued)

building reference sync. The DCVS shall also provide video processing functions such as amplitude control, chrominance gain, sync reinsertion, burst reinsertion, and setup control. The asynchronous video signal shall be processed on input to recreate the sync pulses and subcarrier. Subsequently the signal shall be sampled three times per cycle and converted to a 8-bit digital word format. The digital samples shall be stored in a full frame memory which is read out at the building sync rate. The analog output signal shall be filtered and reference sync, color burst, and output drive provided.

4.4.2.2.5 TV Camera, Operational TV, and Monitors. The cameras currently in use shall be used for OFT.

4.4.2.3 Video Hardcopy Subsystem

4.4.2.3.1 Description. The hardcopy equipment shall be a photo/mechanical-optical/electrical system that records and provides a permanent hardcopy and film record of operator-selected displays containing automatically annotated operator ID, time, and data. A full size image (the same as that on the console monitor, 9.5 x 7.3 inches) shall be provided on the hardcopy and delivered to the console operator by pneumatic tube. The film can be fixed and provides an archival record. There shall be three machines configured to provide for high mission activity times and redundancy to allow for the necessary routine maintenance.

4.4.2.3.2 Functional Requirements. Video information display (text) shall be projected into the hardcopier film by a 10-inch flat face CRT with P11 phosphor. Annotation shall be provided by separate incandescent illuminated readouts that are optically mixed in the light path. Once the information display has exposed the film, the hardcopy system shall:

- Develop the film
- Fix the film
- Wash the film
- Project the contents of the film onto electrostatic paper
- Run the paper through toner for production of hardcopy output.

4.4.2.4 Group Display Subsystem. The group display equipment shall interface with the Plotting Displays Subchannel Data Distributor (PDSDD), the Television and Video Switching Distribution Subsystem, and Discrete Display Subsystem (DDS) to provide large-screen displays, suitable for group viewing to the MOCR, and the Flight Operations Directorate Auditorium (FODA).

4.4.2.4.1 Group Display and Plotting Display Components. The group display equipment shall consist of the following major components:

- Projection plotting displays
- Projection TV displays
- Screens and mirrors.

4.4.2.4.2 Group Display Configuration and Operation

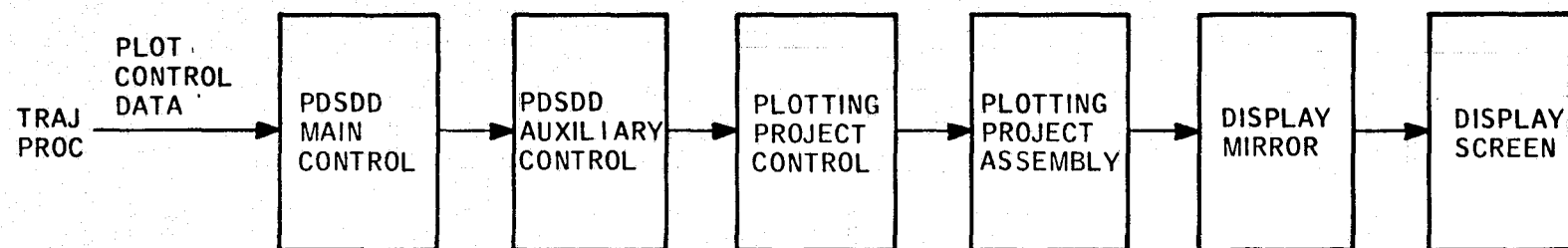
- a. Projection Plotting Displays (Figure 38). These displays shall convert computer-generated data into alphanumeric symbols and vectors for display on large, rear projection group viewing screens. The displays shall be accomplished by the projection of data which shall be scribed on opaque slides by means of servo-controlled styli. There shall be one Projection Plotting Display Subsystem in the MOCR, a 10- by 20-foot array. The projection plotting displays shall include the following components:

- Four scribing (plotting) projectors
- One reference background projector
- Two spotting projectors
- One symbol generator
- Control electronics.

The projection plotting displays shall receive data from only the trajectory processor.

- b. Projection TV Displays (Figure 39). The projection TV display equipment shall employ oil-film light modulation techniques to present high-brightness TV displays for projection to large viewing (group display) screens. The TV information displayed shall include:

- Monochrome alphanumeric data or computer-generated data that has been converted to TV signals
- Color TV signals generated by the FS to NTSC Converter System
- Launch or conference data that is generated by remote TV cameras (MSC/national networks)
- Other RS170 or NTSC live signals as required.

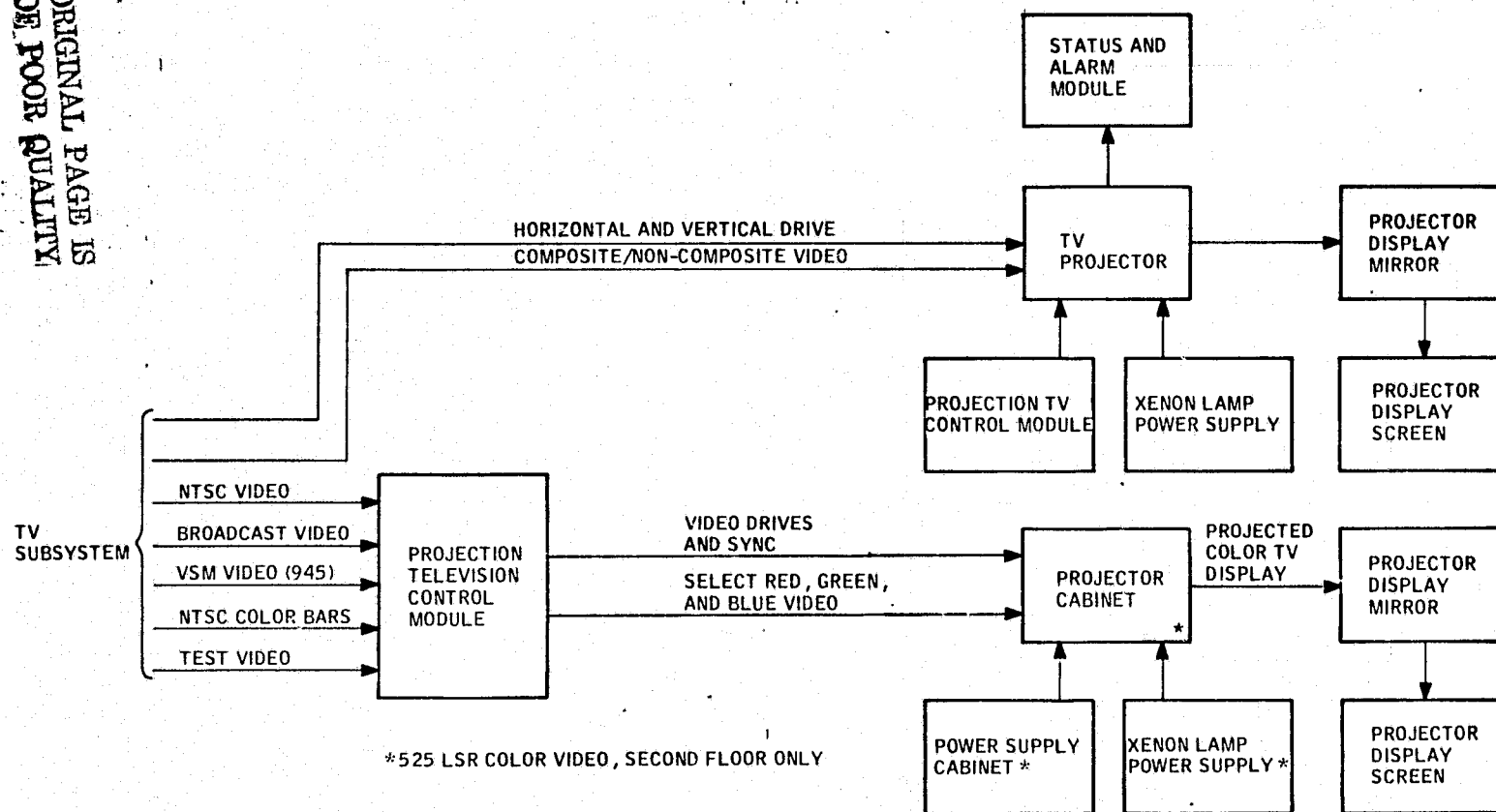


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Figure 38 Plotting Projection Group Display

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Figure 39 MOCR Projection TV Subsystem

4.4.2.4.2 Group Display Configuration and Operation.
(Continued)

There shall be four projection television displays in the MOCR, and one projection television display in the FODA. The MOCR images shall be cast on rear-projection screens with a single optical fold in the horizontal plane. The projector in the FODA shall be located in a conventional projection booth and the image shall be cast on a front-projection screen. One MOCR projector shall selectively display 525-line color or monochromatic video or 945-line monochromatic video. Three MOCR projectors are capable of displaying 945-line monochromatic video. The FOD projector shall selectively display 525-line or 945-line monochromatic video.

- c. Screens and Mirrors. Rear-projection screens, on which images will be focused, shall be located on the forward wall of the MOCR. To reduce the space required behind the screens, each-projection patch shall have an optical fold by means of a single mirror.

4.4.2.4.3 Group Display Interface. The PDSDD shall provide the interface for the transfer and distribution of control signals and plotting data from the DCC to the group display equipment. This data shall control the generation of large-screen projection plotting displays.

4.4.2.4.4 PDSDD Functional Requirements. The PDSDD shall satisfy the following functional requirements:

- a. An interface for data transfer and distribution shall be provided from the DCC to the group display equipment. The data transfer shall be bit serial at a nominal 40.8 kb/s rate.

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4.4.2.4.4 PDSDD Functional Requirements. (Continued)

- b. Limited storage (for each plotting device) for alleviation of excessive delays in data transfer due to plotting device response time shall be provided.
- c. Redundancy for time-shared portions of the PDSDD shall be provided. Capability for selection of either one of the two PDSDD redundant channels shall be accomplished either locally (at the PDSDD) or from a remote configuration control console.
- d. Automatic fault detection techniques shall be used to monitor the status of both the online and standby channel. Errors in either channel shall be indicated both locally and remotely.
- e. Sufficient logic circuitry shall be provided to sense an out-of-order condition in any of the user equipment. In all cases, an out-of-order condition shall simulate an end-of-plot or ready-to-receive signal from the plotter to avoid suspending the portion of the unit that must be time-shared, and to facilitate the flow of data words to all user equipment at all times regardless of an out-of-order condition in any of the PDSDD new plotting device control sections.
- f. The DCC shall transmit via the Discrete Display Subsystem (DDS), digital control data to the PDSDD as a supply voltage for the PDSDD ready line relay. This control signal shall energize and release the relay to control the ready line pulse width of the PDSDD/DCC interface.

4.4.2.5 Discrete Display Subsystem (DDS). The Shuttle DDS shall accept computer language event display data from the DCC and output the data in various forms to the console, timing, and the telemetry and trajectory group displays. The DDS shall provide, as a minimum, the following outputs.

4.4.2.5 Discrete Display Subsystem (DDS). (Continued)

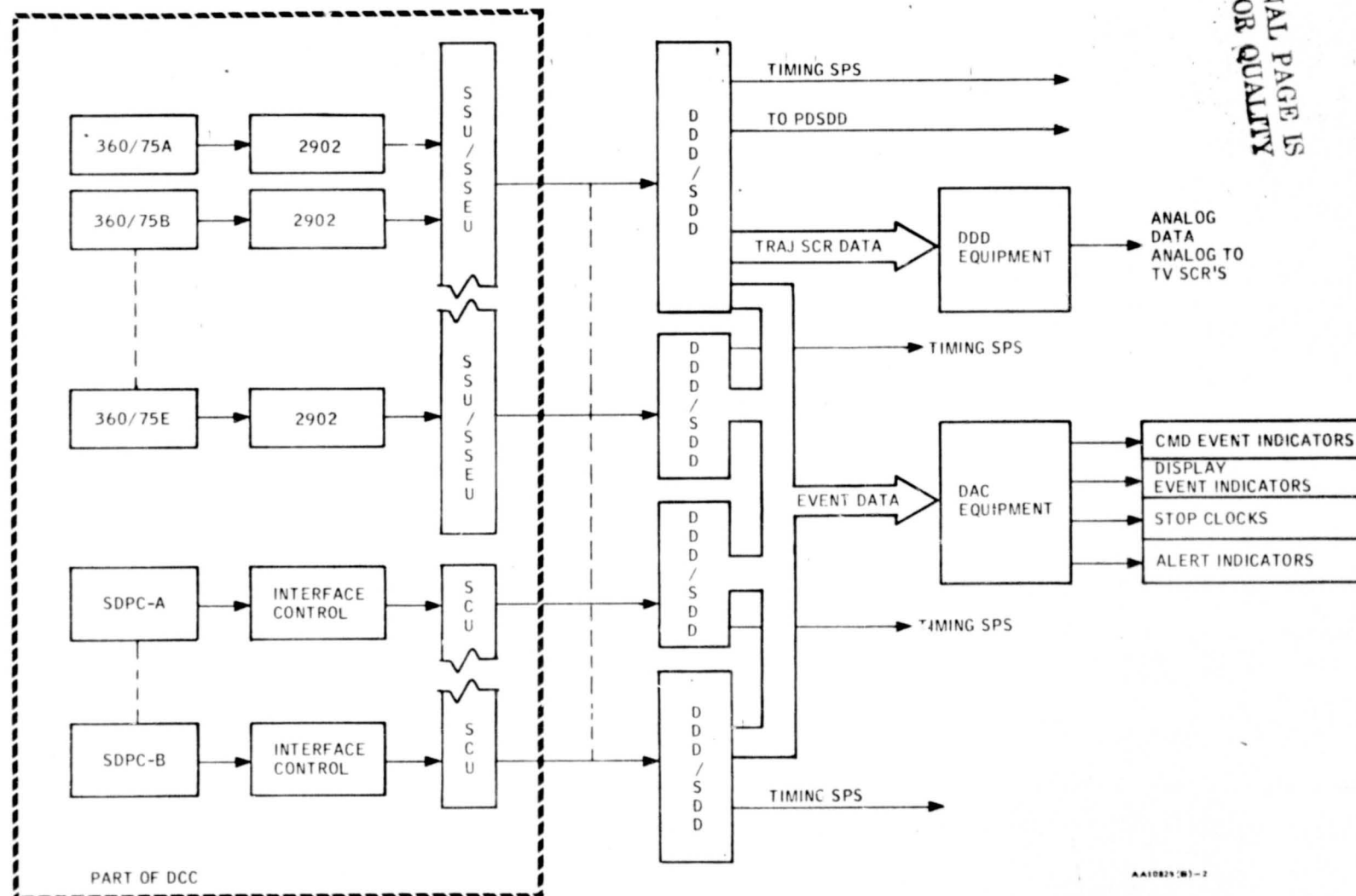
- Lamp drive signals to digital event indicators in the CCSS
- Inputs to TS for time update data and overhead time read-out control data
- Time-constant control data to the PDSDD in the Group Display Subsystem
- Alarm signals for the audible tone alarms in the MOCR or SSR's.
- Digital data inputs for trajectory digital-to-analog converters for subsequent display on trajectory strip-chart recorders.

4.4.2.5.1 Major Subsystem Components. The DDS shall comprise the following major equipment groups (see-figure 40):

- The Digital Display Driver Subchannel Data Distributor (DDDSDD)
- The Digital Display Drivers (DDD's).

4.4.2.5.2 DDD/SDD Functional Requirements. The DDDSDD shall provide the Digital Display Subsystem's interface to the DCC, thru the SCU, accepting input data on multiple serial DCC-DDDSDD data paths, and distributing that data either directly to other Shuttle DCS Subsystems, or to storage and drive circuits in the DDD's. Data received from the DCC shall contain 36-bit computer-language words formatted into information blocks by the originating computer, with the block length being variable as required by the source computer's resident function. Each computer word within the information block shall be individually addressed to permit the DDDSDD to selectively update that word's associated set of display indicators, trajectory recording pens, and/or TS data.

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Figure 40 Discrete Display Subsystem Data Flow Diagram

4.4.2.5.2 DDDSDD Functional Requirements. (Continued)

Distribution control requirements and input data type shall be determined from the terminating device (or user subsystem) address contained in each input word. The DDDSDD shall contain the necessary circuitry to recognize and operate on portions of the data word according to type of data, route the data according to address designation, provide all control signals in the proper time sequence required to update the digital displays, and/or transfer information to the TS.

Distribution of DDDSDD outputs shall be provided by output patch panels contained within that equipment, permitting distribution of any DDDSDD data and control outputs to any desired output device or user subsystem. Of those DDS outputs listed in paragraph 4.4.2.5, only the digitized trajectory analog data and the time update data shall be patched directly from the SDD's to their designated user subsystems. The remaining listed outputs shall require an SDD-to-DDD transfer for storage and signal drive conversion prior to their appearance as inputs to their designated user subsystems.

Address decoding circuits in the DDDSDD shall be capable of decoding up to 4096 unique destination addresses ($64X \times 64Y$). Of these possible 4096 decodable addresses, up to 1600 ($40X \times 40Y$) may be physically patched as DDDSDD outputs at any one time. Each unique address shall determine the DDDSDD output routing for an associated set of data bits.

4.4.2.5.3 DDDSDD Operational Redundancy. The DDDSDD shall contain two internal processing channels, one online and one standby, each containing identical hardware and each capable of independent operation. In nominal operation, both channels shall simultaneously process DCC input data, but only the online channel shall output to user equipment. Changeover from online to standby channel shall be accomplished by a manual replacement of the DDDSDD output patch panel with a prepatched output panel configured for operation with the standby channel. Changeover shall nominally result from visual and/or audible alarm outputs of a common (to both internal channels) error detection circuit.

4.4.2.5.4 DDDSDD Error Detection. Error detection circuits in the DDSDD shall be capable of detecting a variance between online and standby channels, and generating a corresponding failure alarm for the following data types or processing stages:

- a. Computer Data Errors. The DDSDD shall detect non-comparisons between channels for the following computer input data:
 - Computer shift
 - Computer ready
 - DDSDD RTR.
- b. Internal Data Errors. A detected error in either the online or standby channels shall cause the DDSDD to inhibit the acceptance of computer input data and to generate visual and audible alarm signals. Data throughput shall be permitted under the erroneous conditions; however, by the selection of a test mode for the standby channel, the result shall override the error-initiated input restrictions in the online channel.

4.4.2.5.5 Discrete Display Drivers (DDD's). The DDD's shall accept digital event data from the DDSDD and provide equivalent output drive signal outputs to illuminated event indicators.

- a. Functional Requirements. The DDD's shall perform two basic functions, data storage and signal drive generation. The inputs to the DDD's shall be the output of the DDSDD. Data shall be transferred on 24 parallel lines and shall be on a word-by-word basis. The maximum rate of transfer shall be a fixed function determined by the acceptance rate of the DDD's. The display equipment to be driven by the DDD's shall consist of the following types:

4.4.2.5.5 Discrete Display Drivers (DDD's). (Continued)

- Digital readouts consisting of lamp projection displays; two such readouts of 12 lamps each shall be controlled by a single 24-bit data word
- Event indicators, which may have two or three color states such as red/green, or red/yellow/green; up to eight of these indicators shall be controlled by a single 24-bit data word
- On-off indicators (single lamps); up to 24 of these shall be controlled by a single 24-bit data word.

To maintain these displays, the DDD's shall provide the following capabilities:

- (1) Static storage shall be provided, as required, to hold the display information. Inputs to the storage units shall be momentary signals on the 24-bit data input lines accompanied by the necessary control signals required for data transfer.
- (2) Inputs to the DDD's shall have a one-bit-per-lamp correlation. The DDD's shall provide the necessary circuitry to maintain the correlation.
- (3) Gating circuitry shall be provided as required to selectively set and/or reset any 24-lamp set. Selection control lines shall be provided by the DDD's.
- (4) Distribution amplifiers shall be provided on all input lines to provide the drive capability required by the DDD's.

4.4.2.5.5 Discrete Display Drivers -(DDD's). (Continued)

(5) Circuitry shall be provided so that all parallel functions may be driven by one input from the DDSDD.

- b. Data Storage Requirements. The DDS shall provide storage in the DDD equipment of all received data except TS updates and trajectory recorder data. This storage shall consist of bilevel storage for up to 400 24-bit data words in the DDD.
- c. DDD Operational Redundancy. The DDD's shall provide only a single hardware data path between their respective inputs and the user devices, with the interface between the DDD's and user devices being hardwired and nonswitchable in real-time. However, provision of multifunction, overlay-type digital event indicator panels for certain DCC-DDD events shall afford an operationally redundant data path through the DDD's and to the user for those particular lamp driven events. This redundancy shall be realized in the following manner. Loss of a given DDD set and/or its hardwired DDD-to-event panel interface shall require the user to select an available blank multifunction panel (nominally on the same console as the original panel) and condition the new panel to accept the required parameters for display. Program response to the new panel assignment shall cause the original display parameters to be routed through the SDD to a new DDD set and its corresponding output interface to the newly selected panel. This DDD redundancy shall be available only for the lamp driven events, and shall be limited by the immediate availability of spare multifunction panels in the proximity of the original nonuseable panel.

4.4.2.6 Analog and Event Distribution (AED). The AED shall receive digital analog and bilevel event data from the TPC's and distribute this data to analog end event stripchart recorders (SCR's) located throughout the MCC. The AED shall be capable of converting and distributing a minimum of 200 analog and 400 event parameters.

4.4.2.6.1 Functional Requirements. The AED shall be capable of receiving analog and bilevel event data from each TPC, routing that data to the proper SCR and metering the data out at the proper rate. The AED shall be capable of accepting spacecraft time from each TPC and performing a parallel to serial conversion on the timing data for output to the timing pens.

The AED shall convert analog data to an analog output with a nominal resolution of 256 parts per sample.

The AED, in conjunction with the TPC shall provide time correlation within 10 milliseconds or 1/100 of a data cycle, whichever is greater.

4.4.2.6.2 AED/TPC Interface. TBD.

4.4.2.7 Console Subsystem. The Console Subsystem shall provide the physical housing for the majority of display and control end devices required for direct operator interface with the DCC. It shall consist of functionally-grouped keyboards, digital/event indicators and TV monitors mounted in mechanically interlocked multiples of a modular 1-bay console.

4.4.2.7.1 Functional Requirements. The console equipment group shall provide the link between the operator and computer input and output automatic processing equipment, transforming human action into basic encoded messages and computer output words into lamp indications and video displays. The input group shall input to the computer via the DSCIM and CCIM. The output group shall be exercised from the computer via DDDSDD, DTS, and the TS.

4.4.2.7.2 Computer Input Group Functional Requirements.

The following is a list of the minimum requirements for the Console Subsystem computer input group:

- TV channel selection
- Display request selection
- Discrete display format request
- Function code selection and display
- Page forward, reverse, and selection commands
- Page segment selection
- Hardcopy request
- System switching (MOC/DSC)
- Mission-oriented command generation
- DTE status and cluster allocation data
- DCC subrouting selection
- Event sequence override.

4.4.2.7.3 Computer Output Group Functional Requirements. The following is a list of the minimum requirements for the Console Subsystem output group functional requirements.

- Console/site indication
- TV channel indication
- Telemetry input select indication
- Time displays
- Load number indication
- Telemetry, command, tracking, and trajectory event indication
- Biomedical displays
- CRT displays
- TV saturation and status indications.

4.4.2.8 Timing Subsystem (TS). The Shuttle DCS TS shall function as the timing standard for the MCC Shuttle Program. From either actual or simulated sources, the subsystem shall be capable of generating and distributing GMT in various formats and timing

4.4.2.8 Timing Subsystem (TS). (Continued)

pulses at numerous pulse rates. These timing signals shall be used for synchronization and time correlation by other DCS subsystems and MCC systems external to the DCS. In addition to generating timing signals, the TS shall accept either live or simulated launch countdown data and supply this data as countdown timing signals to various display devices during the countdown phase of a mission (or simulation). At countdown conclusion, the TS shall supply a mission or phase-elapsed time to the same display devices that previously displayed countdown time. The TS shall accept inputs from the DCC, AED, or remote control modules to control time word accumulation functions. The TS shall also provide stopclock and time coincidence displays on console-mounted equipment, and control GMT displays on wall clocks throughout the MCC.

4.4.2.8.1 Major Equipment Areas. The timing equipment shall consist of the following equipment:

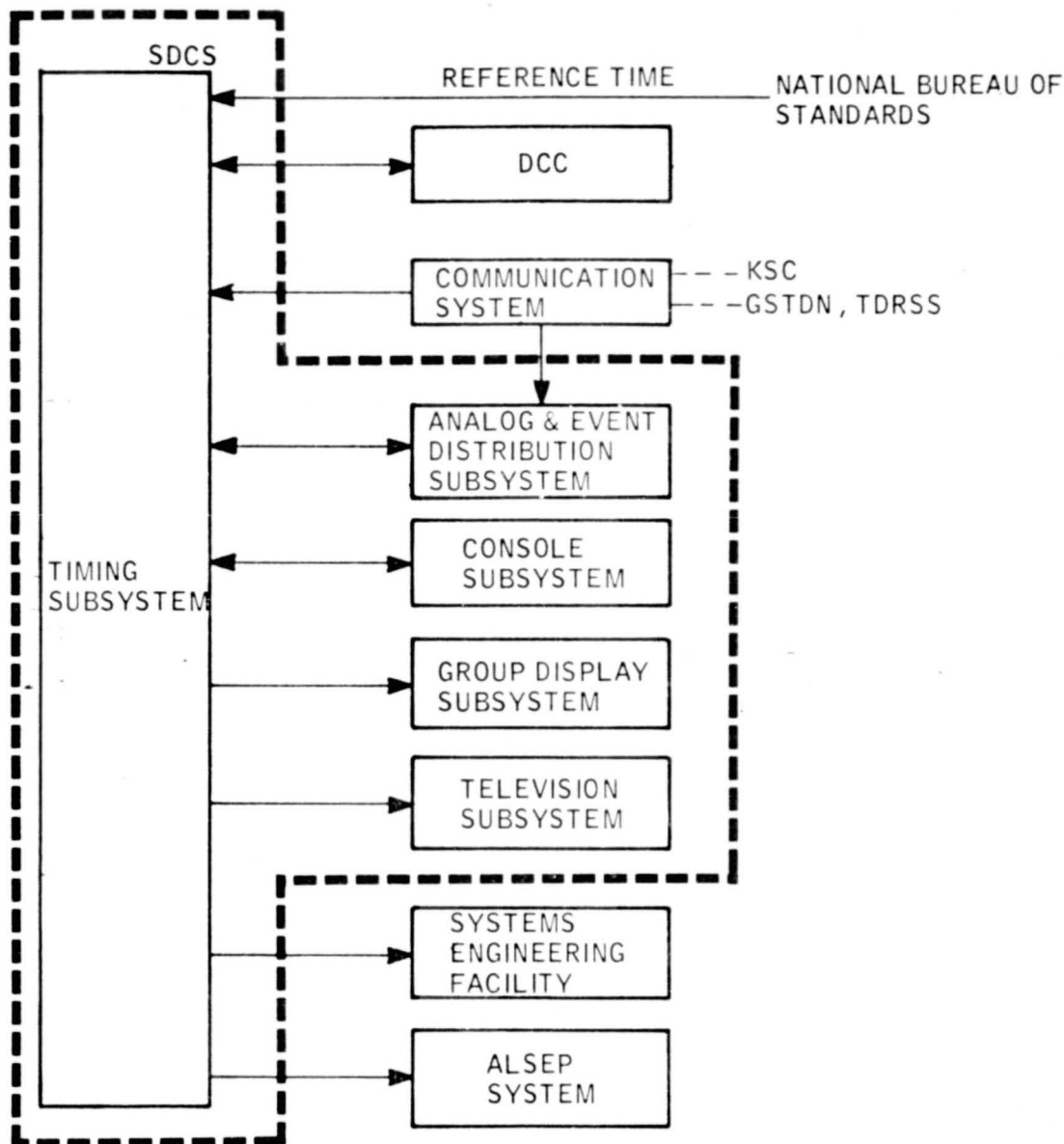
- Master Instrumentation Timing Equipment (MITE)
- Countdown and Status Receiver System (CASRS)
- Time Display/Control Modules
- Wall Clock Equipment.

4.4.2.8.2 Functional Requirements. Both external (to MCC) and internal (within MCC but external to TS) time data sources shall be available to the TS (see figure 41). External sources shall provide live reference time control and real-time vehicle-related time words. Internal sources shall provide real-time general purpose time words and operator controls. In addition, internal sources shall provide the TS with time data equivalent to any live or real-time data.

4.4.2.8.3 Data Sources

a. External Sources

- (1) National Bureau of Standards (NBS). The NBS, through its high frequency radio station WWV,



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Figure 41 Timing Subsystem Interface Data Flow

4.4.2.8.3 Data Sources. (Continued)

shall provide the TS with a universal coordinated time (UTC) standard reference which shall serve as reference for all internal signal generation within the TS.

- (2) U.S. Naval Observatory (USNO). The LORAN-C Navigation System which is closely synchronized with the USNO will, through its low frequency transmissions, provide the TS with reference for time and frequency transfer.
- (3) Launch, Countdown and Status Source. KSC shall provide real-time launch pad-related parameters, including launch-countdown time, hold, and lift-off events. The Simulation Complex shall provide simulated parameters in support of nonreal-time MCC training.

b. MCC Data/Control Sources

- (1) DCC. The DCC shall provide the TS with time control words in real-time for general purpose accumulation function. This control shall be via the DDD/SDD interface.
- (2) Console Circuit Inputs. Operator control of various TS outputs (refer to paragraph 4.4.2.8.4.2) shall be provided from the Console Subsystem.
- (3) AED. The AED shall provide the TS with vehicle or payload time words from telemetry sources.

4.4.2.8.4 Output Signal Generation/Distribution. Thirteen general categories of time signals and parameters shall be provided as outputs of the TS.

- Pulse rates
- Status signals

4.4.2.8.4 Output Signal Generation/Distribution. (Continued)

- GMT and Simulated GMT (SGMT)
- General Purpose Time (GPT)
- Mission-Elapsed Time (MET)
- Phase-Elapsed Time (PET)
- Spacecraft time words
- Secondary clock (wall-clock) supervisory signals
- Accumulated time remote control
- 1 KHz reference time
- Time coincidence signals
- Interrange Instrumentation Group (IRIG) time codes A and B
- TV time display video.

4.4.2.8.4.1 Signal Definition. Each of the 12 general time categories shall contain subgroups of timing parameters as defined in the following paragraphs. Their distribution and utilization is provided in paragraph 4.4.2.8.4.2.

- a. Pulse Rates. Pulse rate generation shall be derived from a Cesium (atomic) standard for stability and reliability and shall consist of redundant pulse rate dividers. Three subgroups shall comprise the pulse rate output capability of the TS: display rates, 945-line video rates, and transmission rates.

4.4.2.8.4.1 Signal Definition. (Continued)

- (1) Display Rates. A total of 15 separate pulse rate outputs shall comprise this group: 1M p/s, 100K p/s, 10K p/s, 2.5K p/s, 2.0K p/s, 1K p/s, 200 p/s, 100 p/s, 10 p/s, 2 p/s, 1 p/s, 30 p/m, 12 p/m, 6 p/m, and 1 p/m.
 - (2) 945-line Video Rates. This subgroup shall comprise the following: clock (21.7728M p/s, horizontal drive, vertical drive, mixed blanking, and composite sync).
 - (3) Transmission Rates. The TS shall be capable of outputting standard transmission rates upon request. A total of 23 separate pulse rate outputs (in pulses per second) are anticipated for sizing the pulse rate dividers: 288K, 230.4K, 224K, 216K, 144K, 100K, 81.6K, 64K, 56K, 50K, 40.8K, 32K, 24K, 19.2K, 9.6K, 4.8K, 2.4K, 2K, 1.8K, 1.2K, 0.6K, 0.3K, and 110.
- b. Status Signals. The TS shall provide (to external systems) status signals to indicate the proper interval generation of prime pulse rates.
- c. GMT and SGMT. The TS shall provide GMT outputs in binary and binary-coded-decimal (BCD) format. BCD outputs shall be in both parallel and serial form, including SGMT.
- (1) Parallel BCD GMT. Parallel BCD GMT outputs shall contain BCD characters provided on interfaces lines, one bit-per-line.
 - (2) Display GMT/SGMT. Display-oriented GMT/SGMT outputs shall be provided by the TS via parallel lines.

4.4.2.8.4.1 Signal Definition. (Continued)

- (3) Parallel Binary Type 2. IRIG PB2.
- (4) NASA Code 2. 28-bit BCD.
- (5) NASA Code 1. 36-bit BCD.
- d. Relative Time Outputs. The TS shall output BCD coded GPT in serial form on interface lines.
- e. Launch Countdown Time. Launch countdown time (LCT), consisting of countdown time, hold, and lift-off signals, shall be provided as an output of the TS. Countdown time shall become MET or PET following liftoff. All outputs shall be provided on serial output lines.
- f. Spacecraft Time Words. The TS shall have the capability to output two spacecraft time words (extracted from downlink telemetry via the AED) in BCD, serial form. The two spacecraft time words for OFT support are TBD.
- g. Secondary Clock (Wall-clock) Supervisory Signals. A TS master clock, synchronized to the National Bureau of Standards reference time, shall output, at 12-hour intervals (2 minutes before 0600 and 1800 hours), a supervisory signal which shall cause receiving wall-mounted secondary clocks to self-regulate to the master clock setting.

4.4.2.8.4.1 Signal Definition. (Continued)

- h. Relative Time Accumulator (RTA) Remote Control Signals. Remote control panels in the Console Subsystem shall provide control for the RTA's during maintenance or simulation periods. These signals shall be provided in the form of active static logic level changes.
- i. 1-kHz Reference Time. The TS shall provide a 1-kHz sine wave reference signal for distribution to external facilities.
- j. Time Coincidence Control Signals. A logic module in the Console Subsystem shall receive GMT and PET from the TS, compare them with preset times in the module, and output start-stop time signals to stop-clocks when a comparison occurs.
- k. IRIG Time. The TS shall output IRIG time in IRIG-A and IRIG-B formats and shall also provide these formats in a modulated output form.

4.4.2.8.4.2 Signal Distribution/Utilization. All external interfaces to the TS shall either terminate or originate in one of these equipment groups. Data flow to other systems or subsystems on these interfaces are defined in the following paragraphs.

- a. TS/Console Subsystem Data Flow. The time display/control modules, listed as a major equipment group in the TS, shall be physically located in the Console Subsystem equipment. The Console Subsystem shall contain the following time display/control modules: time display modules and clocks control modules.

4.4.2.8.4.2 Signal Distribution/Utilization. (Continued)

- (1) Time Display Module. The Time Display Module shall accept time-words from the MITE. These time-words shall be selectively displayed or compared, bit by bit, to a preset time entered by the module operator. When the selected time word coincides with the preset time, either a start or stop (operator selected) shall be internally generated and routed to an internal counter for event time applications.
 - (2) Clock Control Module. A Clock Control Module in the FCR console, shall provide the following inputs to the TS:
 - Accumulator control for all RTA's in the MITE
 - SGMT initiate to the SGMT Accumulators to cause the interval generation of SGMT
 - Simulated launch countdown time to the RTA's in the MITE.
- b. TS/Group Display Subsystem Data Flow. The TS shall provide interfaces to the Group Display Subsystem from the MITE. MITE/group display interfaces shall consist of pulse rates and display time-word outputs. The pulse rates shall be supplied to SCR's; display time-words shall be supplied to the group display units.

Accumulator outputs to the Group Display Subsystem shall consist of Launch Countdown (LCT), MET, GPT, hold signals, and PET. The LCT data shall be routed to the RTA's for output to the group time displays.

4.4.2.8.4.2 Signal Distribution/Utilization. (Continued)

LCT data shall become an incremental count (MET or mission time) following liftoff, and shall be provided to the Group Display Subsystem on the same interface and in the same format as the time signals prior to liftoff. Hold signals shall also be received in the RTA's, and shall be output to the group time displays, where they will be indicated on the large-screen time projections.

- c. TS/TVSS Data Flow. The MITE shall provide interfaces to the TS, consisting of video display formats containing GMT/SGMT and RTA, and shall be supplied to TV monitors in the Console Subsystem and overhead monitors.
- d. TS/Communications Subsystem Data Flow. TS interfaces to the Communications Subsystem shall terminate or originate in the MITE. The MITE shall supply modulated IRIG-A and B to an IRIG Distribution Unit. Data routed to the audio patch bay in the Communications Facility Control Subsystem (FACS) shall be patchable to users in institutional JSC facilities. Data routed to time display units (in FACS) shall be displayed on digital readout devices, and either be direct displays (from MITE) or historical playback from HSD recorders which shall also receive IRIG-B from the MITE.

The voice communications equipment in the Communications Subsystem shall receive and record modulated IRIG-B on audio tapes. It shall also send IRIG-B to the video tape recorder in the TVSS. This data shall ultimately be displayed on time display units in the voice communications equipment.

- e. TS/DCC Data Flow. The TS shall interface the DCC from the MITE. MITE interfaces shall include distribution of pulse rates and parallel or serial BCD GMT to computers, as required.

4.4.2.8.4.2 Signal Distribution/Utilization. (Continued)

- f. TS/ALSEP Data Flow. The TS shall provide pulse rates to the ALSEP DACIU and chart recorders.
- g. TS/SIM Data Flow. The MITE shall provide TS interfaces to the SIM. The MITE shall accept an initial SGMT signal from the clock control console on the simulation supervisor console which shall cause the appropriate SGMT accumulator to begin in the MITE. The same module shall provide an operator-initiated accumulator control signal to the RTA's to control conditions of time accumulators in the MITE during simulations.
- h. TS/Systems Engineering Facility (SEF) Data Flow. The SEF shall receive the signal pulse rates listed in paragraph 4.4.2.8.4.1. These signals shall be available for laboratory research and development as timing sources and references.

4.4.2.9 Display Select Computer Input Multiplexer (DSCIM) Subsystem. The DSCIM shall be capable of detecting, formatting, and multiplexing large numbers of data entries onto single sub-channels to the DCC computers. Data entries shall be accepted as switch closures from DCS console keyboards and reassembled into computer language words for transfer to the DCC in serial form.

4.4.2.9.1 Functional Requirements. The DSCIM shall consist of the multiplexer, input data encoders, and interface circuits. The DSCIM shall accept input data originating as switch closures from console devices and output the data in computer language format to eight DCC computers and to the VSMBM on nine identical serial, simplex 2400 b/s interfaces. The DSCIM shall support the multifunction environment in that it shall be capable of recognizing certain console input devices by their function, which may be variable (under operator control), and outputting their inputs to the DCC computers with the appropriate function identification.

4.4.2.9.2 Multiplexing Requirements. Two multiplexers shall be provided in the DSCIM, one online and one standby. The output of the multiplexers shall be serial, binary 36-bit words.

4.4.2.9.3 Output Interface Requirements. The single serial output of the online DSCIM multiplexer shall be converted within the DSCIM to nine parallel, identical 2400 b/s serial interfaces (figure 42). Eight of these shall interface the DCC, and the ninth output shall be routed to the VSMBM in the DCS DTS.

4.4.2.9.4 Input Source Requirements. Devices inputting to the DSCIM shall be one of the keyboard modules listed in table 3. Each module type shall have a corresponding encoder with the same functional designation (e.g., MSK encoder). The modules shall be console mounted.

4.4.2.9.5 Data Processing Requirements. Each of the module types shall interface a single associated encoder. The DSCIM shall continually scan the encoders in a preassigned sequential order, and shall accept and process either of the following two types of data:

- a. Straight Binary-Coded or Bit-Related Data. All the keyboards except the MSK shall present this type of data on their interfaces to the DSCIM encoders. The DSCIM shall reformat the data, insert a scanning (console) address, and transmit it to the DCC.
- b. BCD Data. BCD data, received from the MSK only, shall be converted to straight binary data and processed as in paragraph a above.

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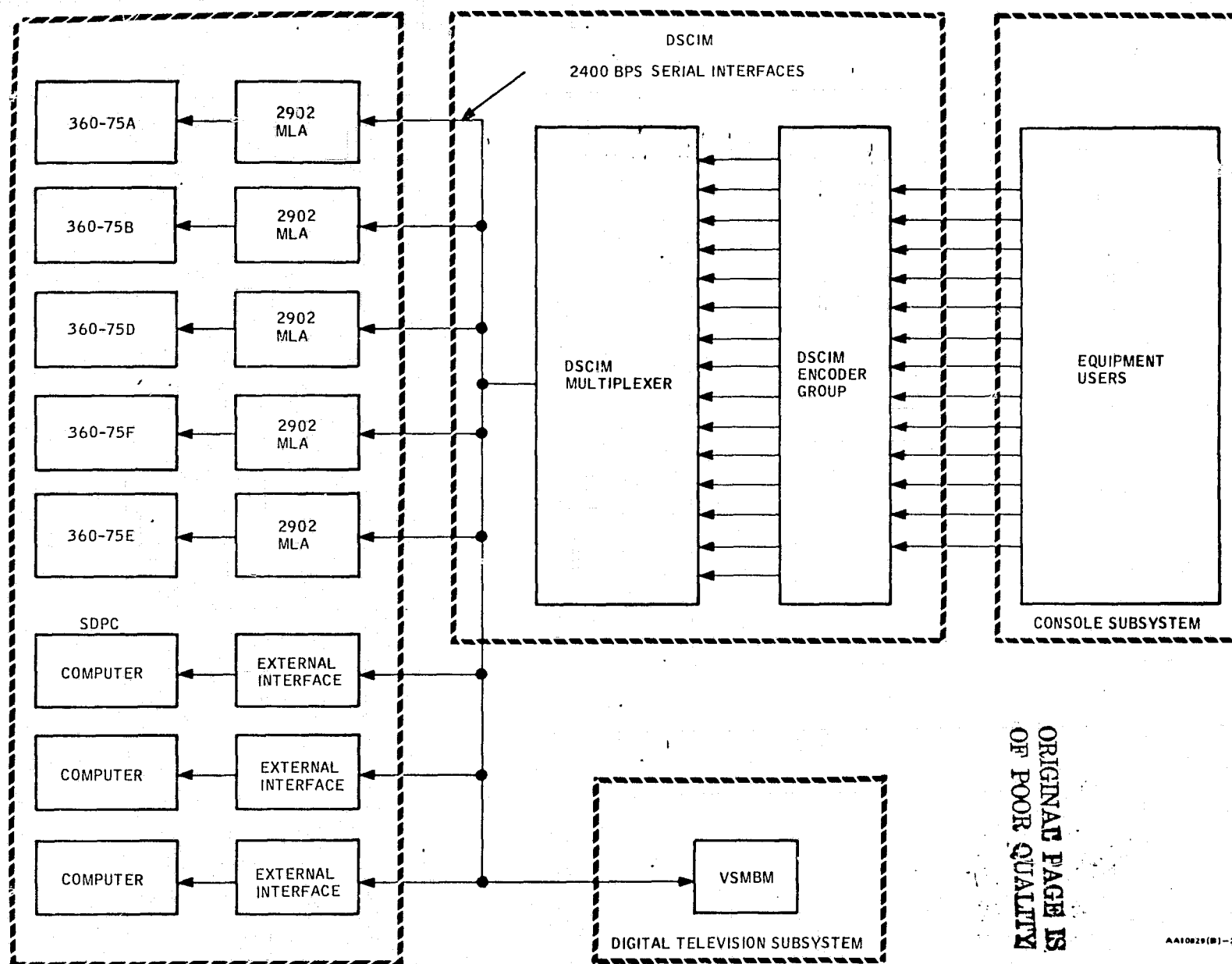


Figure 42 DSCIM Interface Data Flow Diagram

TABLE 3
DSCIM INPUT DEVICES

DEVICE NAME	TYPE OF INPUT
MANUAL SELECT KEYBOARD	TV DISPLAY REQUEST TV CHANNEL ATTACHMENT PAGING REQUEST PROJECTION PLOTTER DISPLAY REQUESTS DDD FORMAT REQUESTS EVENT RELEASE
DISPLAY REQUEST KEYBOARD	TV DISPLAY REQUEST PROJECTION PLOTTER DISPLAY REQUEST
PHASE CONTROL KEYBOARD	COMPUTER PHASE CONTROL COMMAND
SUMMARY MESSAGE ENABLE KEYBOARD	TLM SUMMARY MESSAGE SELECTION
EVENT SEQUENCE OVERRIDE PANEL	EVENT STATUS UPDATING
PROGRAM CONTROL LOGIC MODULE	COMPUTER PROGRAM CONTROL
FORCED DISPLAY KEYBOARD	OUT-OF-LIMIT PARAMETER REQUEST
ESW MODULE	DTE CHANNEL STATUS
CAW MODULE	CLUSTER ALLOCATION COMMAND

4.4.2.9.6 Equipment Status Word (ESW) and Cluster Allocation Word (CAW) Processing. The DSCIM shall provide ESW encoders to inform all eight DCC computers of GO/NO GO status of each DTE channel. In addition, CAW encoders shall assign a cluster or group of clusters to a particular DCC computer.

- a. ESW Processing. The DSCIM shall provide five ESW encoders for accepting 80 individual static level GO/NO GO status indications, one each from the 80 DTE channels. Each of the six encoders shall accept 16 inputs, and each shall have its contents contained in single 36-bit DSCIM output word to the DCC. The DSCIM shall process all six encoder contents, and output all six words in a sequential order to the DCC, under the following conditions.
 - (1) DTE Status Change. A GO/NO GO status change on any one of the 80 ESW inputs to the DSCIM shall cause the DSCIM to output the entire 6-word ESW sequence.
 - (2) ESW Request From DCC. Each of the eight DCC computers shall provide, via its DTE interface unit (figure 42), an ESW request interface signal to the DSCIM. These eight ESW request lines shall be OR'ed within the DSCIM; an active request signal on any one of the eight shall cause the DSCIM to output the entire 6-word ESW sequence to all eight DCC computers. NOTE: The ESW request condition shall also cause the DSCIM to output eight CAW's in sequence (preceding) the ESW's, as defined in paragraph b below.
- b. CAW Processing. The DSCIM shall provide eight CAW encoders, each capable of accepting 20 parallel input lines from the DCCU. These inputs shall contain static logic level representations of DCCU allocations of DTE equipment, with each encoder having a fixed correlation to a DCC computer. The

4.4.2.9.6 Equipment Status Word (ESW) and Cluster Allocation Word (CAW) Processing. (Continued)

DCC CPU code shall be hardwired in the encoder, and shall be output with each of the given encoder's output words to the DCC. The DSCIM shall output a 8-word (one per CAW encoder) sequence to the DCC under the following conditions:

- (1) DCCU Status Change. Any actual DCCU-DTE allocation change occurring in the DCCU shall cause a corresponding change on one or more of the static level input lines to the DSCIM. Any such change shall cause the DSCIM to output the eight CAW's to the DCC.
- (2) ESW Request. The occurrence of the ESW request defined in paragraph 4.4.2.9.6,2 above shall cause all eight CAW's to be output, immediately preceding the eight ESW's.

The multiplexer shall service inputs one at a time (i.e., upon completion of processing one input, it shall proceed to the next position, returning to the previous input in its normal position in the sequential scan frame). Whenever a service request is detected from an input device, further scanning shall be inhibited and the DSCIM shall latch onto the data lines of the requesting device until transmission is complete. Upon completion of transmission, the DSCIM shall provide a transmission complete indication to the transmitting device over a separate line. Simultaneously, the DSCIM shall resume scanning other inputs starting at the next sequential position. In all cases, the DSCIM shall insert, in the first seven bit portions of its serial output, the scanning position in straight binary code which shall be correlated, by the DCC computer, with the input device receiving the DSCIM output.

4.4.2.9.7 Multifunction Support Requirements. The DSCIM shall be capable of supporting a multifunction environment in which simultaneous active functions, residing in and utilizing up to eight DCC computers, will be accepting inputs from the various input devices. In this environment, the DSCIM shall receive a function code from the input device with each input, and insert the code in its corresponding output word to the DCC computers. Each computer shall receive all DSCIM output words, and extract those words whose function code identify its resident function (or functions, if the given computer is configured for multi-jobbing).

4.4.2.10 Command Computer Input Multiplexer (C/CIM) Subsystem. The (C/CIM) shall accept input data (in the form of PBI switch closures) from the Console Subsystem and convert this data into a unique binary code for subsequent transfer to the command processor(s) (SDPC).

4.4.2.10.1 C/CIM Functional Requirements. The C/CIM equipment shall comprise two major hardware functions, an encoding function and a multiplexing function. In addition, the Console Subsystem command type modules shall be discussed in the following paragraphs.

- a. Encoder Equipment Requirements. The C/CIM encoder equipment shall detect, encode, and provide temporary storage for console module initiated requests. Each of the Console Subsystem command modules shall be provided with its own encoder.
- b. Multiplexer Equipment Requirements. The C/CIM multiplexing equipment shall scan the encoders sequentially for detection of a console input. Upon receipt of a console input (to the encoders), the multiplexer shall halt the scan and transfer the encoded data (from the encoders) into the multiplexer section for further formatting and subsequent transfer to the command processor. Upon completion

4.4.2.10.1 C/CIM Functional Requirements. (Continued)

of data transfer to the command processor the scanning sequence shall resume. The C/CIM output word transfer (to the command processor) shall be bit serial at a rate of 2.4 kb/s. Each word shall be 36 bits in length. Two redundant multiplexer channels shall be provided in the C/CIM.

4.4.2.10.2 Hardware Integrity and Safing. In order to maintain the integrity of the C/CIM hardware and to ensure the receipt of error-free, switch encoded command data by the command processor, the following C/CIM hardware functions shall exist:

- a. The true and compliment side of each command module switch shall be sent to its respective encoder.
- b. Switch closure data shall be routed direct from each console module on two separate cables. These cables shall not go through any console Wiring Distribution Module (WDM) or CTC. One cable shall contain the PBI "true" data, the other cable shall contain the PBI "complement" data.
- c. The true and complement PBI data shall be compared by the C/CIM encoders, and by the command processor. The C/CIM shall not output switch data unless a comparison between the true and complement is detected. Likewise the command processor shall not output commands unless a comparison between the C/CIM true and complement is detected.
- d. In order to prevent address skewing, a minimum of two bits shall separate each encoder address.
- e. An even parity bit shall be generated internal to the C/CIM for each data word transferred to the command processor.

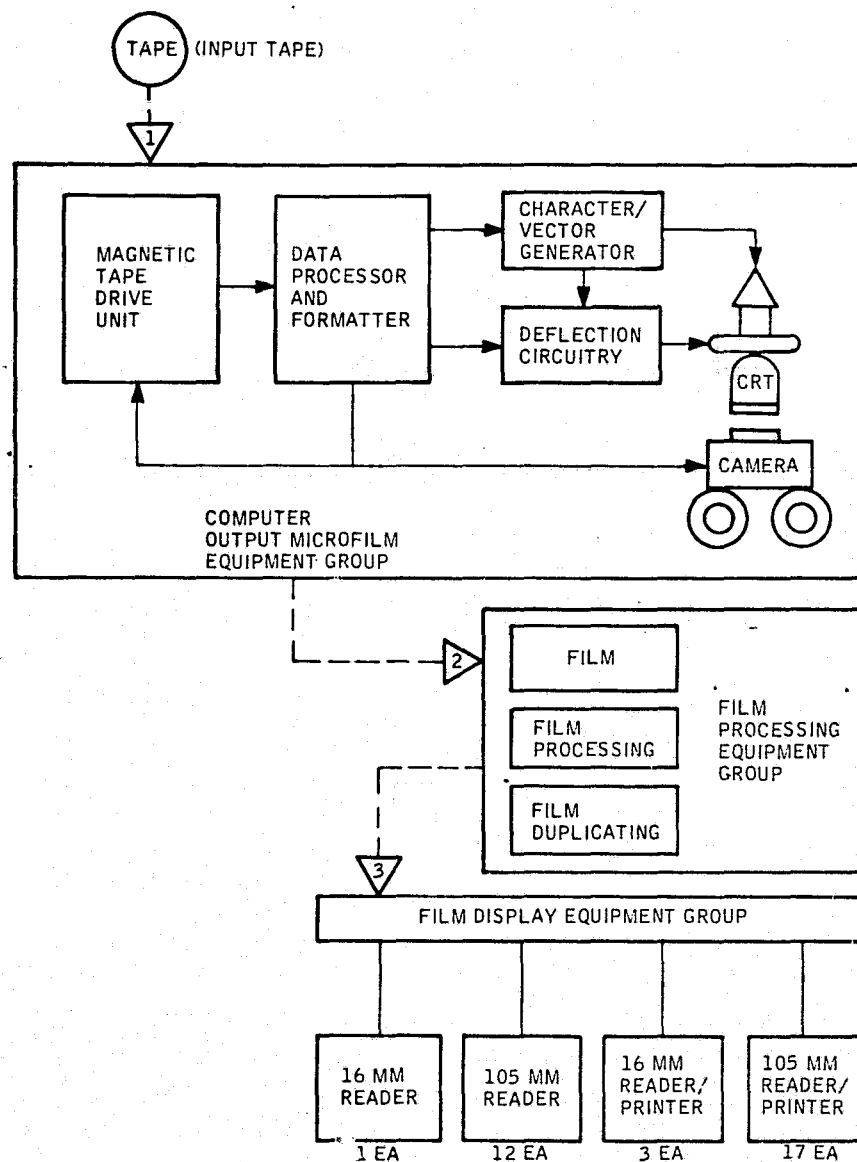
4.4.2.10.2 Hardware Integrity and Safing. (Continued)

- f. A high-speed printer shall be provided for monitoring the C/CIM output to DCC.

4.4.2.10.3 Command Module Types. The following is a minimum listing of the different types of command modules and their function:

- a. Multifunction Command Module. The multifunction command module shall contain a 4×8 matrix of projection readout PBI's; each PBI shall be capable of displaying 12 discrete captions. In addition, the module shall contain 12 field select PBI's for selecting the desired projection readout caption. The module shall have the capability for selecting a total of 384 discrete commands. A depression of the FIELD CLEAR PBI shall disable the module and cause the associated C/CIM encoder to reject all commands generated from the module.
- b. D9/40E Module. This module shall be a 3×6 matrix of double pole double switch (DPDT) momentary action PBI's. The DPDT contacts on the 18 switches shall be wired in such a manner as to create an OCTAL code output for each depression. Each depression shall also provide a TRUE and COMPLEMENT output to its respective encoder for generation of the DUAL data field for transfer to the command processor via the C/CIM.

4.4.2.11 Computer Output Microfilm (COM) Subsystem. COM shall provide the capability for the offline generation of alphanumeric and graphic mission-related information contained on DCC or RTCC output tapes. Capability shall be provided for rapid processing, duplication, and display of high resolution 16 mm, 35 mm, and 105 mm film images. See figure 43.



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Figure 43 COM Subsystem Block Diagram

4.4.2.11 Computer Output Microfilm (COM) Subsystem.
(Continued)

Associated with the COM is the Production Film Converter (PFC). The PFC shall provide high volume conversion of Shuttle Earth Resources Experiment Package (EREP) and Earth Observations Aircraft Program (EOAP) sensor data from digital format to finished film. Additional tasks shall include the capability to provide histograms, plots, and listings of processed sensor data. The film used shall be 70 mm and 5 inch film.

4.4.2.11.1 Major Components. The COM Subsystem shall include the following major components:

- COM equipment group (located in the SOW)
- PFC equipment group (located in the SOW)
- Film processing equipment group (located in the SOW)
- Film display equipment group (located in the MOW).

4.4.2.11.2 System Functional Requirements

- a. COM Subsystem Functional Requirements. The COM must perform the following functions.
 - Provide high resolution 16 mm and 105 mm microfilm outputs identical to all existing formats and displays
 - Accept intermixed alphanumeric and graphic inputs
 - Accept input tapes provided by existing IBM print software

4.4.2.11.2 System Functional Requirements. (Continued)

- Accept input tape provided by existing DTE software
- Provide a minimum of 64 character sizes and accommodate future changes in character repertoire without hardware modification or replacement
- Operate without realignment or maintenance throughout an 8-hour shift
- Accommodate software changes required for specific Shuttle missions without hardware modification or replacement.

b. PFC Subsystem Functional Requirements. The PFC must perform the following functions.

- Provide high resolution 70 mm and 5-inch film images identical to all existing formats and displays
- Provide the capability of recording images on black and white film as well as color film
- Accept intermixed alphanumeric and graphic inputs
- Accept input tapes provided by existing IBM print software
- Accept input tape provided by existing DTE software
- Provide a minimum of 32 character sizes and accommodate future changes in character repertoire without hardware modification or replacement

4.4.2.11.2 System Functional Requirements. (Continued)

- Operate without realignment or maintenance throughout an 8-hour shift
 - Accommodate software changes required for specific Shuttle missions without hardware modification or replacement.
- c. Interface Requirements. The COM and PFC shall operate in a totally offline environment and shall have no external interfaces with online equipment.

4.4.2.11.3 System Description and Specifications

4.4.2.11.3.1 COM Equipment Group. The COM equipment group shall be capable of transforming digital data from magnetic tape into alphanumeric characters or graphic plots on the face of a CRT, and shall record this information on microfilm for subsequent display on a film reader.

- a. Magnetic Tape Unit. The magnetic tape unit shall accept 1/2-inch wide, NRZ 9-track, computer tapes recorded with an 800 BPI density at 37.5 IPS. The tape unit shall accept both 8-1/2-inch and 10-1/2-inch reels.
- b. Computer Format. The system shall be capable of accepting data assembled in IBM 360 SYS OUT and UNIVAC 494 computer print formats and DTE output formats without reformatting by the host computer.
- c. Error Detection. The system shall provide the capability of detecting tape read errors and shall mark the frame or page containing erroneous data with a discrete symbol(s).

4.4.2.11.3.1 COM Equipment Group. (Continued)

d. Alphanumeric Requirements

- (1) Character Set. The system shall provide programmable sets of up to 256 characters consisting of upper case and lower case letters, numerics, and special symbols as required by the various print tape processor programs.
- (2) Character Size. A total of 64 programmable character sizes shall be provided. The character sizes shall vary over a nominal range of 21 to 1, with the largest size being approximately 277 addressable units and the smallest approximately 13 units. The smallest size, as measured on film, shall be equal to approximately 0.0005 inches on the 16 mm camera and 0.0006 inches on the 105 mm microfiche camera.
- (3) Orientation. The system shall provide a minimum of eight software programmable character rotations. The rotations shall be at 45 degree intervals beginning at 0 degree.
- (4) Printing Speed. The system shall be capable of printing alphanumeric characters at speeds of at least 10,000 characters per second.

e. Graphic Requirements. The system shall be capable of generating graphs by plotting dots, lines, and alphanumeric characters and of superimposing several plots on one graph under software control.

- (1) Dot Graphics. The system shall be capable of generating graphs by plotting dots in eight programmable dot sizes. The dot sizes shall vary over a nominal range of 4 to 1, with the

4.4.2.11.3.1 COM Equipment Group. (Continued)

smallest size, as measured on film, being equal to approximately 0.0006 inches or 10 addressable units on 35 mm camera, 0.0005 inches or 12 addressable units on the 16 mm camera, and 0.0005 inches or 10 addressable units on the 105 mm microfiche camera.

- (2) Vector Generation. The system shall be capable of drawing line segments from X,Y origins to X,Y end points anywhere on the addressable raster in eight programmable line widths. The line widths shall vary over a nominal range of 4 to 1, with the smallest size, as measured on film, being equal to approximately 0.0006 inches or 10 addressable units on the 35 mm camera, 0.0005 inches or 12 addressable units on the 16 mm camera, and 0.0005 inches or 10 addressable units on the 105 mm microfiche camera.
- (3) Intensity Levels. The system shall be capable of plotting dots or lines in a minimum of 64 programmable gray scale intensities.
- (4) Plotting Speed. The system shall be capable of plotting adjacent points at speeds of at least 40,000 points per second.
- (5) Line Drawing Speed. The system shall be capable of drawing 10,000 vectors, up to one half the image width, in 15 seconds or less.

f. Film Output and Camera Requirements

- (1) Cameras. The system shall be capable of producing images on 16 mm, 35 mm, and 105 mm film.
- (2) Microfilm Magazines. The cameras shall be equipped with supply and take-up magazines, each having a capacity of at least 200 feet

4.4.2.11.3.1 COM Equipment Group. (Continued)

for 105 mm film, and 400 feet for 35 mm and 16 mm film. The reloadable magazines shall be equipped with footage indicators. A separate footage or frame indicator shall be provided for use with preloaded disposable cartridges.

- (3) Page Format. The system shall provide at least 132 characters per line and 64 lines per page for print simulators.
- (4) Page Recording Rate. The system shall record at least 160 full pages per minute on 16 mm and 35 mm film, and one 105 mm fiche in 1-1/2 minutes with 200 pages per fiche at 50 percent print density.
- (5) Reduction Ratio. The system shall be capable of recording at reduction ratios 20X and 24X on 16 mm film, at 14X and 15X reduction ratios on 35 mm film, and at a 42X reduction ratio on 105 mm film. The system shall provide software programmable reduction ratios for all film sizes.
- (6) Image Orientation. The system shall be capable of recording both CINE and COMIC strip-oriented images.
- (7) Forms Overlay. The system shall be capable of recording static form data in superposition with dynamic data from tape.
- (8) Fiche Titling. Fiche titling shall be provided on 105 mm film. This feature shall be software controlled.

4.4.2.11.3.1 COM Equipment Group. (Continued)

- (9) Stripcharting. The system shall be capable of generating stripcharts on 16 mm film by butting frames. The frame butting accuracy shall be within ± 0.005 inches.
- (10) Cut Marks. Fiche cut marks shall be provided on 105 mm film for automatic film cutting. Cut marks, consisting of three vertical lines in the upper left corner of each film frame outside the data area, shall be placed on 16 mm and 35 mm film.
- (11) Image Retrieval. Image count retrieval marks shall be provided on 16 mm film. MIRACODE and codeline or alternate retrieval systems shall be available as options.

g. Operational Requirements

- (1) Addressability. The system shall have a positioning capability of $16,384 \times 16,384$ locations.
- (2) Resolvable Elements. The system shall contain a minimum of 1024×1024 resolvable elements.
- (3) Linearity. The maximum deviation of alphanumeric characters or vectors from an ideal straight base line shall not exceed 0.1 percent of the maximum addressable image width.
- (4) Repeatability. Repeatability of the system shall be within ± 0.05 percent of the maximum addressable image width.
- (5) Stability. Long term positional stability shall be within ± 0.05 percent of the maximum addressable image width after 8 hours of operation.

4.4.2.11.3.1 COM Equipment Group. (Continued)

- (6) Monitor Display. The capability to monitor the image being generated on a CRT display monitor shall be provided. The monitor shall also verify operator communication with the system for maintenance and program development.
- (7) Hardware Diagnostics. Hardware diagnostics, as a minimum, shall be provided for the CPU and associated core memory, character and vector generating elements, the disk storage system, and the magnetic tape units.
- (8) Optical Alignment. Alignment of the camera and image generating elements shall be a nominal operator function that shall require no more than 5 minutes to complete.
- (9) Ambient Conditions. The system shall perform as specified when operated over the ambient temperature range of +68 to +78 degrees Fahrenheit at 40 to 60 percent relative humidity.
- (10) Power. The system shall operate as specified with a single phase primary power input of 120 V ac ± 10 percent at 60 Hz, ± 5 percent.

4.4.2.11.3.2 PFC Equipment Group. The PFC shall be capable of transforming digital data from magnetic tapes into alphanumeric characters, graphic plots, or sensor images on the face of a CRT, and shall record this information on microfilm for subsequent display on a film reader.

a. Input Requirements

- (1) Magnetic Tape Units. The magnetic tape units shall accept 1/2-inch wide, NRZ, 9-track, computer-compatible tapes recorded with a

4.4.2.11.3.2 PFC Equipment Group. (Continued)

density of 800 bytes per inch. The tape units shall accept 8-1/2 and 10-1/2 inch reels and shall read at a speed of 75 IPS or greater. Interfaces shall be provided for the addition of up to two additional 800-byte-per-inch magnetic tape units.

- (2) MED. The MED shall provide input capability for initialization and modification of internal software. The device shall be logically equivalent to an ASR 35 TTY and shall include paper tape read and punch capabilities.
- (3) Buffer Storage. The system shall provide sufficient buffer storage to maintain maximum throughput.
- (4) Disk Storage Device. A disk file with storage for at least 250,000 18-bit words shall be provided for storage of internal preformatted instructions.
- (5) Input Formats. Input formats shall be compatible with the basic requirements as defined in the specific software requirements document. Input data shall consist of 8-bit bytes assembled into 16-bit words in records of up to 3,060 bytes.
- (6) Error Detection. The unit shall provide the capability of detecting tape read errors and shall mark the image area containing erroneous data with a discrete symbol.

4.4.2.11.3.2 PFC Equipment Group. (Continued)

b. Film Output Requirements

- (1) Film Size. The unit shall record data on continuous rolls of either 5-inch film or 70 mm film as selected by the operator.
- (2) Film Type. The capability for recording images on black-and-white film or color film shall be provided. Both positive and negative film types shall be accommodated.
- (3) Film Quality. The recording film selected for operational use shall be compatible with the operating parameters of the film converter and the film processor and shall be readily available, off-the-shelf types. Black-and-white film shall allow image recording with a nominally straight line response of 64 equal density steps of 0.025D, or less, above gross film fog which shall not exceed 0.3D when processed to gammas up to 2.0. Color film shall provide a straight line response of 16 equal density steps of 0.1D, or less, above gross film fog with gammas up to 2.0.
- (4) Image Format. Sensor image data shall be recorded in the continuous and framed image formats. The image width across 70 mm film shall not exceed the nominal allowable image width of 2.295 inches. Continuous imagery shall occupy up to 1.955 inch and annotation up to 0.340 inch. All dimensions shall be within ± 0.025 inch. The image width across 5-inch film shall be a nominal 2X expansion of the 70 mm image size, (4.59-inch maximum, 3.91-inch continuous image width, and 0.68-inch annotation). Output formats and annotation required are specified in the appropriate experiment software requirements document.

4.4.2.11.3.2 PFC Equipment Group. (Continued)

- (5) Print-Plot Formats. Output formats for tabular listings and plots of sensor nonimage data shall be provided full frame in CINE or COMIC mode and shall be as specified in the appropriate experiment software requirements document.

c. Alphanumeric Capability

- (1) Character Set. The unit shall provide complete sets of 128 characters consisting of upper case letters, lower case letters, numerics; and special symbols in ASCII, EBCDIC, and BCD codes.
- (2) Character Sizes. The unit shall provide at least 32 software programmable character sizes and shall permit recording of up to 355 characters per line as a maximum.
- (3) Orientation. The unit shall provide a minimum of four software programmable character rotations: 0, 90, 180 and 270 degrees.
- (4) Print Speed. The unit shall be capable of printing alphanumeric characters at speeds of at least 10,000 characters per second.

d. Graphic Capability

- (1) Dot Graphics. The unit shall be capable of generating image data by plotting dots in eight programmable dot sizes.

4.4.2.11.3.2 PFC Equipment Group. (Continued)

- (2) Vector Generation. The unit shall be capable of drawing line segments from X,Y origins to X,Y end points in eight programmable line widths.
- (3) Scan Generation. The unit shall be capable of plotting dots, line segments, or lines along precalculated linear or conical paths up to 180 degrees.
- (4) Intensity Levels. The unit shall be capable of generating image data by plotting dots or lines in a minimum of 64 programmable gray scale intensities. Capability of 128 intensities shall be available as an option.
- (5) Plotting Speed. The unit shall be capable of plotting adjacent points at speeds of at least 40,000 points per second.
- (6) Line Drawing Speed. The unit shall be capable of drawing 10,000 vectors, up to 1/2 the maximum image width, in 15 seconds or less.

e. Operational Requirements

- (1) Addressability. Each element shall be addressable to $16,384 \times 16,384$ locations.
- (2) Resolvable Elements. The unit shall provide a minimum of 4096×4096 resolvable picture elements at a minimum of 64 programmable gray scale intensities and 16 color intensities.
- (3) Positional Accuracy. The deviation from the absolute value between centers of any two adjacent picture elements shall not exceed plus or minus one part in 16,384 in the horizontal and vertical directions. Accumulated deviation

4.4.2.11.3.2 PFC Equipment Group. (Continued)

of picture elements in a scan line from the ideal straight or conical scan line shall not exceed 0.05 percent of maximum image width. Accumulated deviation of vertically aligned elements from an ideal straight vertical line of one image length shall not exceed 0.05 percent of maximum image width.

- (4) Camera Accuracy. Image alignment and frame butting accuracies shall not exceed the minimum thickness of one image scan line or one part in 4096.
- (5) Repeatability. Repeatability of the unit shall be within plus or minus one part in 32,768 when a given point or character is repeated up to 20 times.
- (6) Stability. Long term positional stability shall be within 0.05 percent of the maximum image area after 8 hours. Densitometric stability shall be within $\pm 0.025D$.
- (7) Intensity Variation. Density changes for a given intensity value shall not vary more than 2 percent of D maximum, over the entire image area.
- (8) Film Cut Marks. Film cut marks for automatic cutting of the frames images shall be provided.
- (9) Film Capacity. The unit shall utilize reloadable film cartridges having a minimum capacity of 200 feet of 70 mm or 5-inch film. The cartridges shall be equipped with footage indicators, and shall be daylight replaceable.

4.4.2.11.3.2 PFC Equipment Group. (Continued)

- (10) Spare Cartridges. Spare film cartridges shall be provided for each film size and type.
 - (11) Process Monitor Display. A process monitor display shall be provided to verify data processing and shall be used interactively with the manual entry device for modification of internal software.
- f. Throughput Requirements. The unit shall be capable of processing image, plot, and print data in the times specified. Throughput times for image processing shall be within ± 10 percent of the specified values with input data tapes formatted for one channel of black-and-white imagery data, or three channels of color data, and a maximum PIXEL word length of eight bits. The image processing time shall include film annotation and frame advance times, but does not include the process initialization time; i.e., the time required to read the header, generate image correction tables, and record the job descriptor frame on film.
- (1) Continuous Image Mode. Minimum throughput times for exposing black-and-white continuous images shall be:
 - 1000 PIXEL's per scan line at 13 lines per second
 - 2000 PIXEL's per scan line at 6 lines per second
 - 4000 PIXEL's per scan line at 3 lines per second.

4.4.2.11.3.2 PFC Equipment Group. (Continued)

- (2) Framed Image Mode. Minimum throughput times for exposing black-and-white framed images shall be:
 - 1000 × 1000 PIXEL's at 75 seconds per image
 - 2000 × 2000 PIXEL's at 300 seconds per image
 - 4000 × 4000 PIXEL's at 1200 seconds per image (ERTS type of data).
- (3) Color Throughput Times. Throughput times for color imagery shall not exceed four times the basic black-and-white time.
- (4) Plot Data. Adjacent points shall be plotted at speeds of at least 40,000 points per second.
- (5) Print Data. Characters shall be recorded on film at speeds of at least 10,000 characters per second.

4.4.2.11.3.3 Film Processing Equipment Group

- a. Film Processing. The film processor unit shall perform in accordance with the following specifications:
 - (1) Capacity. The system shall have the capacity to process up to 400 feet of 16 mm and 32 mm film, or 200 feet of 105 mm, 70 mm, and 5-inch magazine film continuously.
 - (2) Processing Speed. The system shall process 16 mm and 32 mm film at 20 feet per minute, 70 mm and 5-inch film at 15 feet per minute, and 105 mm film at 5 feet per minute.

4.4.2.11.3.3 Film Processing Equipment Group. (Continued)

- (3) Film Processing. The system shall permit random daylight loading and processing of positive or negative film.
- (4) Film Output. The system shall provide, by selection of chemicals, either positive or negative silver microfilm output of archival quality (10-year storage).
- (5) Chemical Replenishment. The system shall use containers of premixed chemicals completely contained in the processor enclosure. Space for reversal chemicals shall also be provided.
- (6) Ventilation. The system shall produce no discernible odor under nonvented conditions.

b. Film Duplicator. The film duplicator unit shall perform in accordance with the following specifications:

- (1) Capacity. The system shall provide the capability to duplicate up to 400 feet of 16 mm or 200 feet of 105 mm film.
- (2) Copying Speed. The system shall provide variable speeds up to 100 feet per minute.
- (3) Film Duplication. The system shall permit random daylight loading and copying.
- (4) Film Output. The system shall accept silver microfilm inputs and provide diazo duplicate negatives as an output.
- (5) Motor Control. The system shall provide features which automatically stop the process if the original or copy film breaks.

4.4.2.11.3.3 Film Processing Equipment Group. (Continued)

- (6) Footage Indicator. An indicator shall be provided to monitor the film supply.

4.4.2.11.3.4 Film Display Equipment Group

- a. Reader and Reader/Printers (16 mm). The 16 mm film readers and reader/printers shall perform in accordance with the following specifications.

- (1) Film Accepted. The system shall accept 16 mm nonsprocketed silver microfilm in preloaded 16 mm cartridges.
- (2) Magnification. The magnification ratio shall be at least 24X.
- (3) Screen. The screen shall be not less than 11 × 14 inches with a nonglare, white, gray, blue, or brown surface.
- (4) Film Threading. The system shall provide automatic film threading capability for preloaded 16 mm cartridges.
- (5) Controls. The system shall provide on-off, focus, motorized forward and reverse drive, image rotation and illumination controls as a minimum.
- (6) Hardcopy. The microfilm reader/printers shall provide the capability to produce black on white, permanent, dry, 11 × 14-inch hardcopies.

- b. Fiche Reader and Reader/Printers. The fiche readers and reader/printers shall perform in accordance with the following specifications.

4.4.2.11.3.4 Film Display Equipment Group. (Continued)

- (1) Film Accepted. The system shall accept 105 mm microfilm.
- (2) Magnification. The magnification ratio shall be at least 42X.
- (3) Screen. The reader screen shall not be less than 11 x 14 inches with a nonglare, white, gray, blue, or brown surface. The reader/printer screen shall not be less than 8-1/2 x 11-inches with a nonglare, white, gray, blue, or brown surface.
- (4) Controls. The system shall provide on-off, focus, and illumination controls as a minimum.
- (5) Hardcopy. The microfiche reader/printer shall provide the capability to produce black-on-white, permanent dry, 8-1/2 x 11-inch hardcopies.

4.4.2.12 Terminal Systems. TBP.

4.4.2.13 OPS Transition. TBP.

4.5 Building Arrangements. The Bldg. 30, MOW for Shuttle OFT, functional areas and equipment arrangements are defined in the following paragraphs. Detailed information pertaining to cabinet or console configurations can be obtained in the individual equipment specifications or SISO-TR155.

4.5.1 MOW First Floor. The MOW first floor shall be configured as shown in figure 44. The major functional responsibilities of the MOW first floor shall consist of:

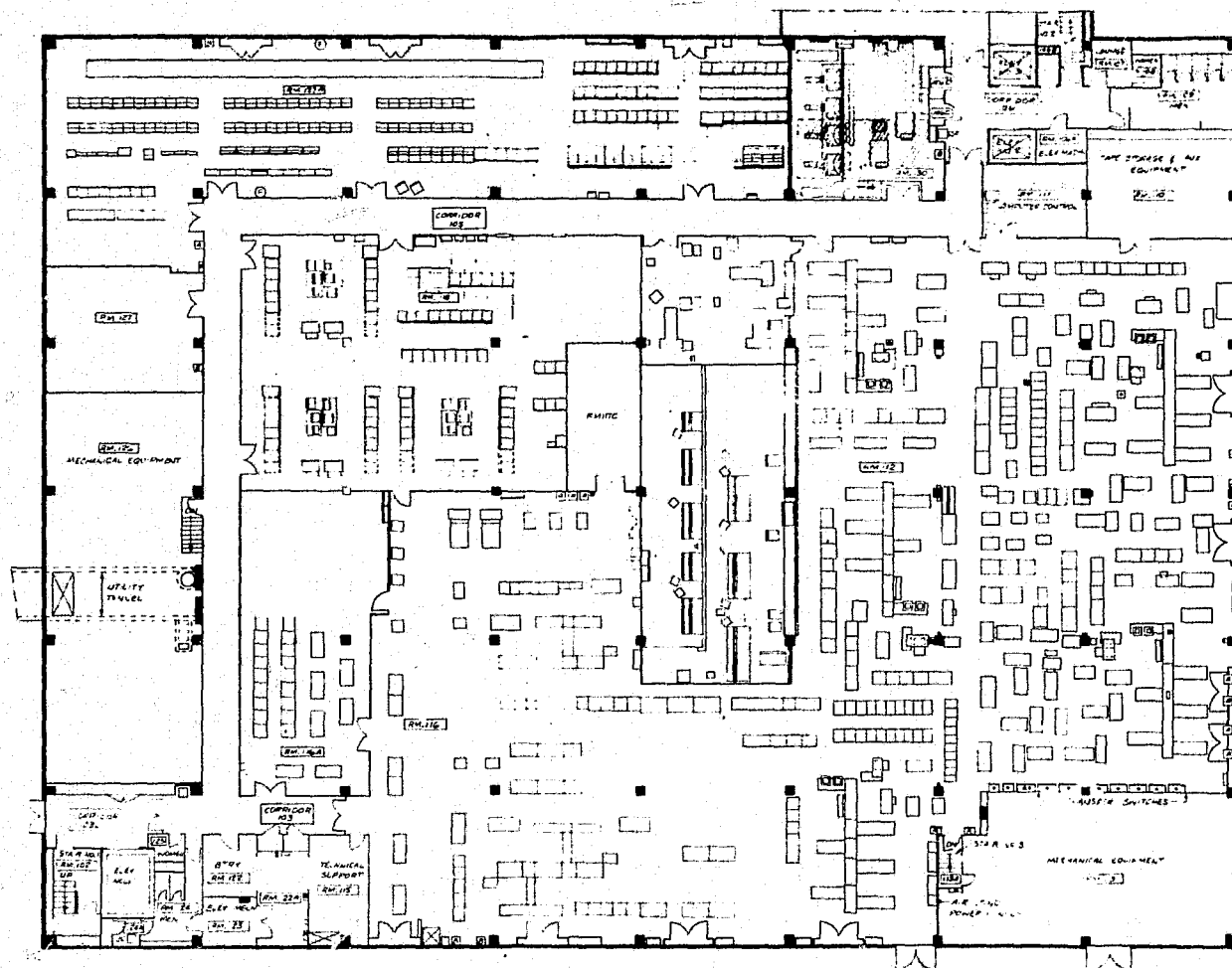
- Incoming/outgoing MCC data processing
- Communications switching/routing
- Software Development Lab
- Pneumatic tube control
- Storage of processing resources
- Equipment/software monitoring and control (360/75, SDP).

4.5.2 MOW Second Floor. The MOW second floor shall be configured as shown in figure 45. The major functional responsibilities of the MOW second floor shall consist of:

- OFT mission monitoring and control
- Equipment/software monitoring and control (TCS)
- OFT simulations monitoring
- Message center
- ALSEP support
- RJE control.

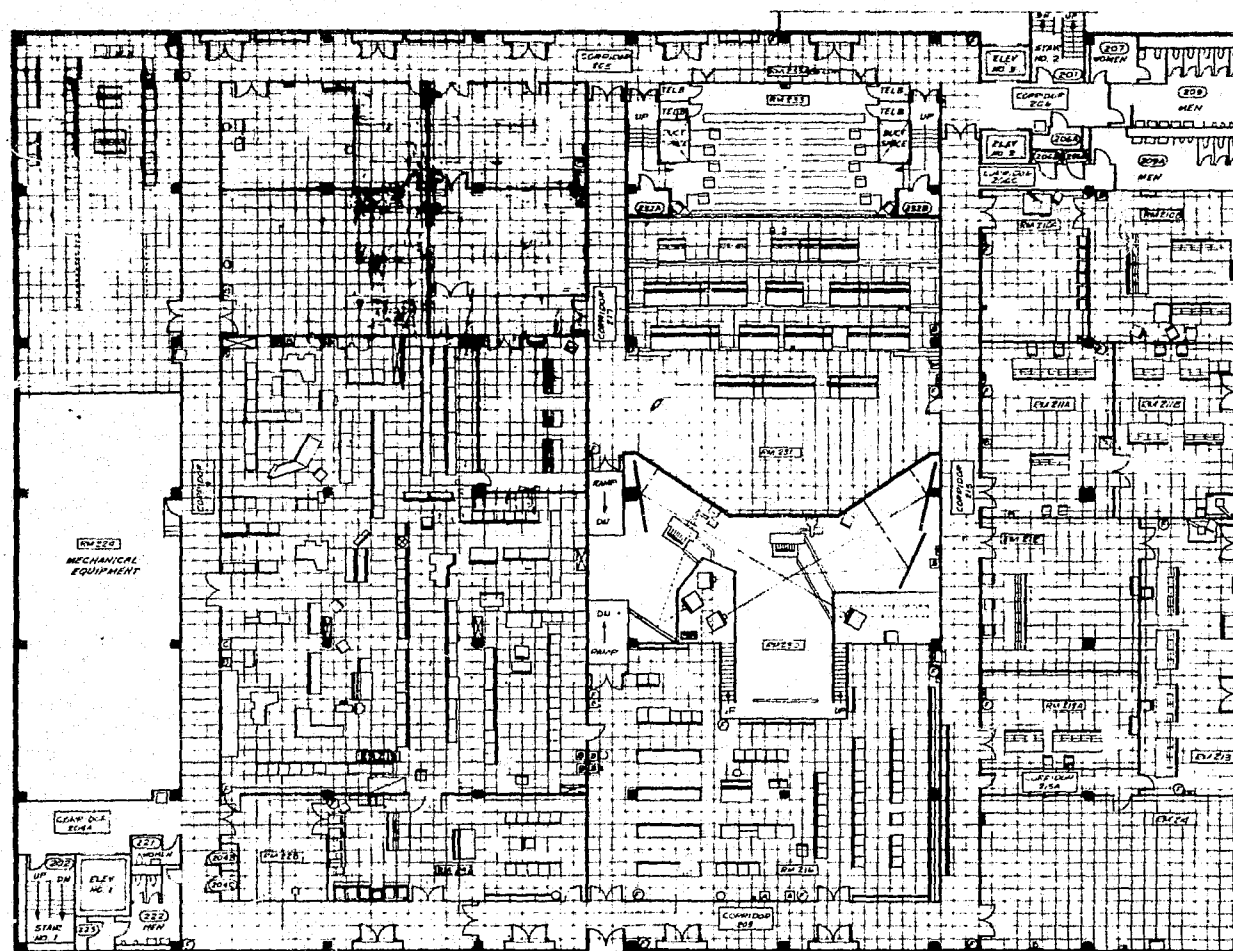
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97 ROOM NO. 97
98 ROOM NO. 98
99 ROOM NO. 99
100 ROOM NO. 100

Figure 44 MOW First Floor Equipment Arrangement



LEGEND OF SYMBOLS

○ CLOCK

□ ZONE FIRE ALARM PANEL

△ 'A' POWER PANEL

◇ 'B' POWER PANEL

⊙ FIRE EXTINGUISHER

ROOM NO.	ROOM NAME	ROOM DNG. NO.
210A	OPERATIONS DATA RM	ND - 00007
210B	OPERATIONS SSC	ND - 00008
211A	ATM SERVICE RM	ND - 00009
211B	SSC/ENV SSC	ND - 00010
212	FLIGHT OPERATIONS MANAGEMENT	ND - 00011
212A	ARCHIVED/NOV EIP SSC	ND - 00012
213	CSM/DNS SSC	ND - 00013
214	FUTURE SCA & MIE	ND - 00014
216	CONTROL & DISPLAY TERMINAL	ND - 00015
219	ASCATS	ND - 00016
225	HISTORICAL RECORDING	ND - 00017
226	ASSETS MAINTENANCE AREA	ND - 00018
227	SUBSTANCES GCE & CENTRAL	ND - 00019
	REPAIR	ND - 00020
229	7041	ND - 00021
230	SUMMARY DISPLAY PROJECTION	ND - 00022
231	MISSION OPERATIONS	ND - 00023
	CONTROL ROOM	ND - 00024
232A	COMM 300TH	ND - 00025
232B	VISITORS VIEWING AREA	ND - 00026
242	CTM'S & MIEP INTERFAC	ND - 00027

Figure 45 MOW Second Floor Equipment Arrangement

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4.5.3 MOW Third Floor. The MOW third floor shall be configured as shown in figure 46. The major functional responsibilities of the MOW third floor shall consist of:

- ALSEP support
- Display Evaluation Lab
- MEDICS
- Earth resources
- Housing for equipment supporting second floor operations.

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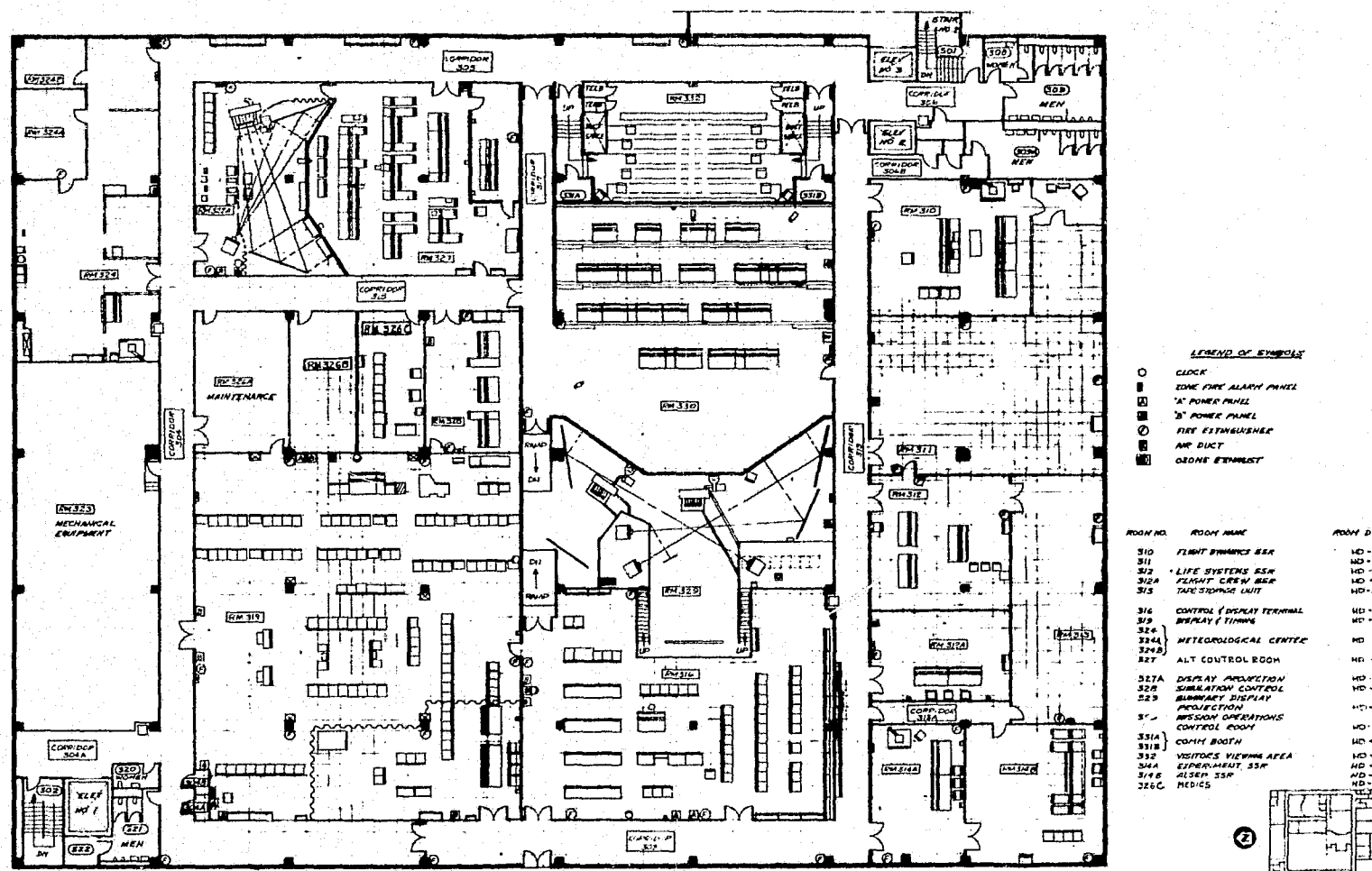


Figure 46 MOW Third Floor Equipment Arrangement

4.6 Reliability. Reliability (R) is defined as the probability that a system of equipment can meet an operational objective during a finite interval of time.

The following paragraphs shall be used to specify a numerical reliability requirement for the mandatory equipment strings, to enumerate such equipment strings necessary for the successful support of the Shuttle Orbiter, and to identify fixed redundancies that are independent of mission requirements. The reliability estimates obtained from equipment and system evaluations is dependent on groundrules and operational philosophy developed on a mission-to-mission basis.

4.6.1 Reliability Requirements. The reliability of each string shall be $R = 0.9995$ for a time interval equal to the sum of the critical mission periods occurring at commencement of countdown for Orbiter launch, continuing through the orbital test flight, and ending at the termination of the flight test. During critical phases, prolonged periods of interrupted control cannot be tolerated. While failure criteria vary among various subsystems, it is generally accepted that failures which can be remedied by immediate switchover to standby equipment are not considered system failures. Conversely, failures which require repair of failed components or necessitate reinitialization of the system are considered system failures.

4.6.2 Configuration Identification. The reliability requirements shall apply to functional strings of mission critical equipment. The function of the string shall be identifiable and specified. The accomplishment of this function shall be criteria for measuring successful mission support.

Critical equipment shall be identified as the equipment mandatory for the successful support of the OFT missions. These equipment strings are identified as follows.

- CCTFC
- NIP

4.6.2 Configuration Identification. (Continued)

- SDPC
- 360/75 Computer Complex
- Video display
- Discrete Display Subsystem
- AES
- Timing Subsystem
- Display select.
- Command select.

4.6.2.1 CCTCF

4.6.2.1.1 Boundaries. The analysis of the CCTCF Subsystem string shall be limited to the portion of the string which provides terminations for external wideband data, digital voice data, high-speed data, and teletype circuits entering and leaving the MCC. The wideband data string, including the digital voice data elements, shall comprise the following equipment.

- Modems
- Data line switch
- MBI
- NOM
- Delta MOD/DEMOD
- Multiplexer/Demultiplexer
- SCU.

4.6.2.1.1 Boundaries. (Continued)

Functioning separately, but utilizing some equipment common to the wideband data string, the high-speed data string shall be comprised of the following elements:

- VF patch
- Modems
- Data line patching equipment
- Impact Predictor Data Control Unit-R (IP DCU-R)
- SCU.

The TTY string shall encompass the following elements:

- TTY patch
- VFTG.

The analyses that shall be performed on the WBD string elements, the HSD string elements, and the TTY string elements shall be limited to the elements that handle external telemetry data for the Orbiter vehicle.

4.6.2.1.2 Criticality. Critical elements within the CCTCF can be categorized into critical WBD (including digital voice), HSD, and TTY functions. The WBD functions shall include the processing of all external wideband data received from the STDN network. However, HSD functions are only defined as the processing of the launch impact predictor data from either of two IBM data control units. TTY data that is considered critical is low-speed radar data at launch.

A loss of a critical function within the WBD, HSD, or TTY requiring the repair of a failed element to restore system support is defined as a system failure.

4.6.2.1.3 Special Considerations

- a. Hardware Redundancy. Nonreconfigurable fixed hardware redundancy shall exist for those WBD, HSD, and TTY functions that are constant for mission-to-mission operation requirements. All equipment implementation, augmentation, or modification should be reviewed from mission-to-mission to ensure that the necessary redundancy is present so the system performance does not degrade below the levels attained for previous missions.
- b. Operational Redundancy. As the HSD is considered mandatory only during the launch phase and hardware redundancy shall exist within the string, no requirement for operational redundancy for the HSD elements exist. However, critical WBD and TTY data shall be routed along independent paths to multiple users. Sufficient operational redundancy, therefore, is required so that the system performance does not degrade below the levels attained for previous missions.

4.6.2.2 NIP

4.6.2.2.1 Boundaries. Analysis of the NIP string shall be limited to the portion of the CIS containing the following elements:

- NCIC
- NCIU
- TPC
- DVS.

4.6.2.2.2 Criticality. Critical functions of the NIP shall be as described in paragraph 3.4.1.3. Loss of a critical function requiring repair of a failed element for support restoration shall be defined as a system failure.

4.6.2.2.3 Special Considerations. Minimum equipment redundancy shall be provided in the NIP Subsystem elements where sufficient operational functional redundancy exists to assure system success. Failover to redundancy channels shall be accomplished without loss of data.

4.6.2.3 SDPC

4.6.2.3.1 Boundaries. Analysis of the SDPC shall be limited to the requirements specified in the RFP. In response to the RFP, the bidders shall provide a reliability analysis of the system configuration that involves creation of graphical reliability models, conversion of the graphical models into mathematical models, and the solving of the mathematical models to provide the reliability prediction.

4.6.2.3.2 Criticality. A system string capable of providing support is composed of a central processor with 3.2 MB of addressable memory and direct access storage with a minimum storage capacity of 100 MB. The direct access storage device shall be equipped with a removal storage pack easily replaced. A computer restart/selectover module shall be considered critical in the sense that it provides resource allocation, initialization, failover, and restart function for the SDPC.

4.6.2.3.3 Special Considerations. The SDPC shall provide uninterrupted support for data transfers on the input interface. Output interfaces shall be allowed a 200 ms interruption in the event that selectover is required. During the selectover interval, each output interface shall assume a quiescent state at the

4.6.2.3.3 Special Considerations. (Continued)

end of each respective message transfer and remain in that state throughout the switching period. Switching shall not be initiated until all output interfaces are in a quiescent state and the DTE signals that selectover is required. The processing cycle shall not be interrupted during the selectover interval.

In addition, the system shall receive restart signals from a remote PBI module when a dynamic standby mode is used. Restart shall require a dump of all addressable memory of the online central processor. During restart the online central processor shall continue to process incoming data.

Fault detection, prediction, and isolation shall be automated by the use of build-in test equipment and maintenance computer programs. Where possible, built-in diagnostics shall be used to the maximum extent; otherwise, facilities for offline diagnostics shall be modular so that additional routines may be incorporated to test growth items as they are added. Diagnostic programs shall be in a language compatible with the operational program.

4.6.2.4 360/75 Computer Complex

4.6.2.4.1 Boundaries. Analysis of the 360/75 computer string shall be limited to the portion of the equipment that provides processed mission critical information to the DCS and to mission designated Shuttle data processors. An equipment string capable of providing mission support is composed of a central processor and a number of peripheral devices.

4.6.2.4.2 Critical Functions. Critical functions performed by the 360/75 computer string shall include but not be limited to outputting processed real-time and nearreal-time trajectory data. Critical equipment in this string shall be comprise of the following.

- IBM 2075 Central Processor

4.6.2.4.2 Critical Functions. (Continued)

- IBM 2365 Processor Storage
- IBM 2361 Large Core Storage
- IBM 2860 Selector Channel
- IBM 2870 Multiplexer Channel
- IBM 2902 Multiplex Line Adapter
- IBM 2701 Data Adapter
- IBM 2314 Direct Access Storage Facility
- IBM 4606 SSU/SSEU
- Computer Restart/Selectover Module.

4.6.2.4.3 Special Considerations

- a. Hardware Redundancy. The 360/75 Computer Complex is presently composed of five real-time data processing systems; four are available for mission support. Of the four computers configured for mission support, one system is designated as the MOC, one is designated as a DSC, and the remainder are designated as standby computers in the offline mode.

The processed outputs from the MOC and the DSC are routed to a SSU/SSEU which provides a means by which the DSC computer can be switched to become the MOC computer. The SSU/SSEU receives switching signals from the computer restart/selectover module. Upon receipt of the proper signal, the SSU/SSEU activates a relay which takes the MOC outputs offline and switches the DSC computer online to become the MOC.

4.6.2.4.3 Special Considerations. (Continued)

In addition, the restart/selectover module provides for updating (via commands) the offline computers to a dynamic standby mode via a channel-to-channel transfer. After a failed computer has been repaired, it can be restored to a dynamic mode by use of a coldstart technique initiated from the restart/selectover module. The requirements for Shuttle OFT are such that at least one computer system must be operational for a mission support period.

- b. Failover Considerations. If a MOC malfunction occurs, the computer restart/selectover module issues a signal to the SSU/SSEU which provides switchover to the DSC. Should the switchover occur, one of the two offline processor strings is transformed to a DSC mode via a channel-to-channel transfer. This transfer involves a core dump which takes approximately 10 seconds. In the case of the MOC that originally malfunctioned, it is taken down, repaired, and restored to an offline status.

In the event the DSC malfunctions; it is removed from a DSC status and replaced with one of the offline computers. This is upgraded to a DSC status by means of a channel-to-channel transfer. The process essentially involves a core dump from the MOC to the offline computer. It is initiated from the restart/selectover module and takes approximately 11 seconds. This process restores the MCC to an active MOC and an active DSC configuration. The restart/selectover module also provides a signal to the SSU/SSEU which prevents a premature switchover to the failed DSC.

4.6.2.5 Video Display

- 4.6.2.5.1 Boundaries. Analysis of the video display string shall be limited to the portion of the equipment used for conversion of computer generated digital data into raster-type video and

4.6.2.5.1 Boundaries. (Continued)

equipment that controls computer allocation of these resources by providing TV address data and video switching of these resources to selected output channels for distribution to various users. Equipment in this string shall be comprised of the following:

- Computer Restart/Selectover Module
- DTE
- DCCU
- DTE Interface Cabinet (DTEIC)
- VSM
- VSMBM
- Display Select Computer Input Multiplexer.

The analysis that shall be performed on each equipment group of the video display string is inclusive only to the extent of the impact on the acceptance of computer derived data, reformatting of this data, and transmission of the data to a CRT monitor for operator viewing.

4.6.2.5.2 Critical Functions. Each equipment component shall be an integral part of the overall video display system. The functions performed by these components shall be essential to the following extent.

- a. Computer Restart/Selectover Module. Originates a selectover function that conditions the DCCU to re-allocate the DTE clusters from an online computer to a designated backup computer.
- b. DTE. Performs conversion of digital data from designated computers into raster-type video for display on CRT screens. In addition equipment status words

4.6.2.5.2 Critical Functions. (Continued)

(ESW's) are provided to signify the operational status of each video channel.

- c. DTE Cluster Control Unit. Provides cluster/computer allocation, allocation exchange, and allocation re-assignment controls to the DTE clusters. Also provides allocation status information to the display select CIM.
- d. DTE Interface Unit. Functions as an intermediate termination point for signals passing between the DCC and the Input Interface Modules (IIM's) of the DTE.
- e. VSM. Provides high resolution switching from a number of video sources to selected output channels for distribution to various television viewers, television projectors, and recording equipment.
- f. VSM Buffer Multiplexer. Multiplexes the address data from the CIM and DTE to the VSM on a priority basis to provide the TV channel, console, and monitor address for VSM control of its input to output designations.
- g. Display Select CIM. Allocation words containing DTE cluster and channel availability are provided to the computers in the DCC.

System failure is defined as any anomaly that will cause the critical functions to degrade below mission requirements.

4.6.2.5.3 Special Considerations

- a. Hardware Redundancy. Fixed channel, nonreconfigurable redundancy shall be an integral part of the hardware for functions that are independent of

4.6.2.5.3 Special Considerations. (Continued)

mission-to-mission operational requirements. This type of redundancy, identified in *Reliability Baseline Analysis of the Video Display String Equipment*, PHO-TN321, exists in the following video display string equipment:

- Computer Restart/Selectover Module
- DTE Cluster Control Unit
- VSM Buffer Multiplexer
- Display Select Computer Input Multiplexer (Multiplexer cabinet only).

Subsequent equipment modifications shall be reviewed to ensure that sufficient redundancy is retained to prohibit system performance from degrading below that experienced for previous missions.

- b. Operational Redundancy. Data distribution of critical events shall be routed on independent paths to multiple users. Viewer assignments made on a mission-to-mission reconfiguration basis shall provide sufficient operational redundancy so system performance is not degraded below that experienced for previous mission support (reference PHO-TN321).

4.6.2.6 DDS

4.6.2.6.1 Boundaries. Analysis of the DDS shall be limited to the portion of the Control Display System which receives computer generated event data from the DCC and distributes the data for display on console event module indicators, timing, and the telemetry and trajectory group displays. The DDS shall be comprised of the following equipment:

- Digital Display Driver Subchannel Data Distributor (DDDSDD)
- Digital Display Drivers (DDD).

4.6.2.6.1 Boundaries. (Continued)

The analysis that shall be performed on the DDS shall be limited to those elements that handle lamp driver signals to the digital event indicators in the console subsystem.

4.6.2.6.2 Critical Functions. Critical functions within the DDS shall be defined as that processing associated with driving the variable event modules within the consoles. If a loss of a critical function occurs within the DDS requiring the repair of a failed element to restore system support, the failure shall be defined as a system failure.

4.6.2.6.3 Special Considerations

- a. Hardware Redundancy. Nonreconfigurable fixed hardware redundancy shall exist for those discrete display functions that are constant for mission-to-mission operational requirements. Redundancy shall be required insofar as the system performance does not degrade below the levels attained for previous missions. Reference paragraphs 4.4.2.5.3 and 4.4.2.5.5,c for more specific information regarding the DDSDD and DDD redundancy requirements.
- b. Operational Redundancy. Critical data shall be routed along independent paths to multiple users to ensure operational redundancy. Sufficient operational redundancy is required so that the system performance does not degrade below the levels attained for previous missions. Reference paragraphs 4.4.2.5.3 and 4.4.2.5.5,c for more detailed information on operational redundancy requirements.
- c. Failover. Failover capability to redundancy hardware channels shall be required only for the DDSDD. The switchover to a standby SDD channel shall be accomplished by a manual replacement of the DDSDD output patch panel with a prepatched output panel configured for operation with the standby channel.

4.6.2.7 AES

4.6.2.7.1 Boundaries. Analysis of the AES shall be limited to the portion of the subsystem which receives digital, analog, and bilevel event data from the TPC and converts and distributes a minimum of 200 analog and 400 bilevel event parameters to analog and event stripchart recorders located throughout the MCC.

4.6.2.7.2 Critical Functions. Critical functions of the AES shall be limited to the processing (excluding TPC) and distributing of both analog and bilevel event data as defined in paragraph 4.4.2.6.1. Loss of a critical function requiring the repair of a string element to restore system support shall be defined as a system failure.

4.6.2.7.3 Special Considerations

- a. Hardware Redundancy. Sufficient nonreconfigurable hardware redundancy shall exist in the receiving, processing, and distributing portions of the AES to minimize the probability of system failure.
- b. Operational Redundancy. Hardware redundancy shall not be required for the AES analog and bilevel script chart recorders event (SCR's); however, the AES design shall provide capability for sufficient operational and/or functional redundancy at the end-item devices.
- c. Failover Considerations. Failover to redundant channels shall be accomplished without loss of data displayed on analog and bilevel event recorders. There shall be sufficient reconfiguration capability in the MCC Configuration Control Computer for reallocating selected analog and bilevel event parameters for subsequent display on SCR pens.

4.6.2.8 Timing Subsystem String

4.6.2.8.1 Boundaries. Analysis of the timing subsystem string shall be limited to the portion of the system which generates and distributes time reference signals for use by select MCC subsystems.

4.6.2.8.2 Critical Functions. Critical functions within the timing subsystem shall be as defined in paragraph 4.4.2.8.4. Critical distribution and utilization shall be as defined in paragraph 4.4.2.8.4.2 with the exception of the following which shall not be considered as critical within the timing subsystem:

- ALSEP
- SIM
- SEF.

System failure shall be defined as degradation that will cause loss of a critical function or distribution which requires repair of a failed element prior to support restoration.

4.6.2.8.3 Special Considerations

- a. Hardware Redundancy. Hardware redundancy shall exist for the portion of the timing subsystem which generates and divides the time reference signals. This portion shall include standards, synchronizers, synthesizers, and pulse rate dividers.
- b. Operational Redundancy. Reconfigurable operational redundancy shall exist for signal drivers and timing subsystem interfaces.
- c. Failover Considerations. Failover capability to redundant channels shall be provided. This capability shall include switchover of offline redundant channels to the online mode without loss of timing subsystem support to the subsystem interfaces.

4.6.2.9 DSCIM

4.6.2.9.1 Boundaries. Analysis of the DSCIM shall be limited to the portion of the display select system that receives its inputs from PBI depressions in the console subsystem, encodes or formats the inputs into 36-bit words, and outputs the words to the SDPC's and the 360/75's. End item keyboard devices are included in the analysis for critical path determinations.

4.6.2.9.2 Critical Functions. The functions critical to the DSCIM are contained in paragraphs 4.4.2.9.1 through 4.4.2.9.7 of this specification. System failure shall be defined as any failure which causes the loss of a flight controller's (FC) display select capability in support of a critical FC position.

4.6.2.9.3 Special Considerations

- a. Hardware Redundancy. Sufficient hardware redundancy exists for the DSCIM multiplexer to meet reliability requirements. At the encoder level, hardware redundancy presently exists for the modules listed in table 3 except for the following:

- Program control logic
- Forced display keyboard
- Equipment status word (ESW) module

Configurations shall be established to make these encoders redundant.

- b. Functional Redundancy. Functional redundancy for the DSCIM may be implemented using a MED; i.e., a teletype physically mounted on individual consoles. The MED shall be capable of communicating with both the dynamic and standby processors.

4.6.2.9.3 Special Considerations. (Continued)

- c. Operational Redundancy. Operational redundancy shall be implemented for the encoders whenever possible. Redundant encoders shall be configured so that they reside in the same logic drawer of a cabinet, rather than different logic drawers of different cabinets. Operational redundancy presently exists for the devices listed in table 3 except for the modules contained in paragraph 4.6.2.9.3,a. Operational redundancy may also be accomplished by the assignment of various console keyboard inputs to the encoders on a mission-to-mission basis.
- d. Failover Considerations. Switchover to a redundant multiplexer in the DSCIM shall be accomplished manually. The time required to switchover from the active online multiplexer to the standby multiplexer shall be less than 200 ms.

4.6.2.10 CCIM

4.6.2.10.1 Boundaries. Analysis of the command select string shall be limited to the part of the system originating computer input data from console mounted switches on command consoles. Command consoles shall be defined as having the capability to initiate a request for transmission of essential data from the MCC to the Orbiter and for transferring data between ground computers.

4.6.2.10.2 Critical Functions. The following CCIM functions shall be necessary for Shuttle support during critical mission periods:

- Initiation of real-time commands emanating from the command modules listed in paragraph 4.4.2.10.3

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4.6.2.10.2 Critical Functions. (Continued)

- Selection of desired command mode; i.e., abort, enable/disable, etc.
- Verification of commands received by the spacecraft
- Proper encoding of command words as they are initiated by the command consoles and received by the encoder circuits
- Verification of a proper command words
- Transfers of command words from the encoders to the CCIM
- Scanning of encoders to detect command console inputs.

The success criteria for equipment contained in the CCIM string shall be defined as the ability to provide uninterruptible execution of the functions listed above.

4.6.2.10.3 Special Considerations

- a. Equipment Redundancy. Sufficient equipment redundancy shall exist in the CCIM control cabinet to meet reliability requirements.
- b. Functional Redundancy. Functional redundancy may be implemented for command console initiated inputs in lieu of equipment redundancy specified in paragraph 8.3.10.3,a. This could be accomplished by using the teletype as backups for command inputs to the CCIM.
- c. Operational Redundancy. Operational redundancy shall be implemented in the encoder circuits (as listed in paragraph 4.4.2.10.1 of the CCIM system. This involves consideration of the interfaces between command consoles and encoder circuits, and shall be used whenever possible.

4.6.2.10.3 Special Considerations. (Continued)

- d. Failover Considerations. Switchover to a redundant channel in the CCIM control cabinet shall be implemented on a manual basis. Appropriate failure detection and subsequent switchover circuitry shall be retained for the CCIM. The internal circuitry of the CCIM control cabinet shall be configured so that effective switchover can be accomplished in 200 ms or less. At the encoder level, switchover from a failed encoder shall be accomplished by reinitiating the command from a different console.

5. MCC SOFTWARE SYSTEMS

5.1 Introduction. TBS.

5.2 Operating Systems. A computer operating system is a set of programs and routines which guide a computer in the performance of its tasks and assist the programs (and programmers) with certain supporting functions. The operating system for each computer in the MCC shall provide the environment and the specialized software tools required by the applications programs.

The operating systems used in the MCC shall be standard vendor supplied systems plus augmentations required to satisfy the special MCC demands. All of the large scale operating systems provide the same, or very similar, functional capabilities despite the different hardware architectures and the different design philosophies.

The programs and routines of an operating system can be divided into the following functional groups.

- a. Job Management. Responsible for organizing and regulating the flow of work in a system by selecting, initiating, and controlling the execution of tasks.
- b. System Resource Management. Allocates and maintains the status of resources to tasks and programs selected for execution. Resources typically include memory, CPU time, tapes, disks, printers, timing services, etc.
- c. Data Management. These functions consist of file management facilities, input/output (I/O) support facilities, and data management system facilities.
- d. Systems Management. Concerned with system generation, systems maintenance, program maintenance, and compiler interfaces.

Although all large operating systems are composed of these functional components, this division is probably not suited for the description of any specific operating system.

5.2.1 Shuttle Data Processing System (SDPS). To be provided.

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5.2.2 Data Processing Computation Complex (DPCC). To be
provided.

5.2.2.1 Enhanced Operating System (EOS). The Enhanced Operating System (EOS) is the support system for the System 360 Model 75's in the Real-Time Computer Complex (RTCC).

The EOS is based on release 21.8 of operating system multiprogramming with variable number of task (OS MVT) providing multijobbing. The EOS meets the following five goals.

- a. Requires a minimum number of OS MVT captures.
- b. Provides support for OS MVT and local services.
- c. Provides an efficient, high performance operating system for the RTCC.
- d. Compatible with OS MVT support services and program products.
- e. Requires a minimum amount of local maintenance support.

The control program in the operating system performs supervisory and service functions that increase the efficiency of job step execution. These include job initialization, supervision of a job throughout its life in the system, and the disposition of the job at termination. The following paragraphs discuss the major functional areas of the EOS in a high level design specification format. If detailed technical information is desired in any of the functional areas, refer to the bibliography in section 2 of this document.

5.2.2.1.1 Job Management. Job management routines prepare a job for processing by the operating system. The basic unit of work in a computing system is commonly referred to as a job. Job management routines process input streams, allocate resources, schedule and initialize the job, process system output, and schedule and execute operator commands.

5.2.2.1.1 Job Management. (Continued)

- a. Processing Input Streams. Jobs are presented to the operating system in input streams consisting of job control language statements and data records. The reader/interpreter formats the input stream into a form acceptable to the system and builds control blocks containing the interpreted information. The interpreted records are written to a job queue data set on a direct access device a physical track at a time thus reducing arm movement on the disk. The records are also buffered in an in-core job queue area eliminating the need for the majority of disk I/O when a job queue record is requested by the system. The job is enqueued on the input queue based on the priority value and class. The class is determined by the main memory required, number of tapes requested, system output space, time, and disk work space.
- b. Scheduling and Initialization. The initiator routines select jobs from the input queues, transfer control to the resource allocation routines, and pass information to task management for controlling the execution of the job. Control is subsequently passed to the application program. When the job terminates, its resources are freed and any messages and system output data sets are added to the job's output queue entries.
- c. Resource Allocation. The control blocks built by the input stream processor are used to determine what I/O devices to allocate before the job is scheduled. In addition to preallocating the appropriate devices, an alternate method of dynamic device allocation enables the application to dynamically allocate/deallocate tapes, printers, and card punches during job execution. Resource allocation routines also obtain an area of main storage for use by the application.

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5.2.2.1.1 Job Management. (Continued)

- d. System Output Processing. System output consists of messages from the operating system to the programmer and system output data sets. Following termination of the job, the system output is retrieved by the writer routines and written on devices specified by the operator. The output can be written to printers, tapes to be printed later, or to computer output microfilm (COM) tapes to be converted into microfilm/microfiche.
- e. Command Processing. Command processing consists of scheduling and executing operator commands. Command scheduling synchronizes command execution with other events in the system. The operator has commands for starting system tasks such as readers and writers, manipulating input and output queues, displaying the status of jobs in the system, and abnormally terminating any job executing in the system.

5.2.2.1.2 Task Management

5.2.2.1.2.1 Task Supervision. Task supervision consists of the creation and scheduling of services for all tasks in the system.

- a. Task Creation. Task creation involves the building of a task control block (TCB) and related control blocks that describe the task to the operating system. There are three types of tasks that can be created in the EOS: each has unique functional capabilities.
 - (1) Dependent Task. This task ceases to exist when the task completes its unit of work and returns to the task supervisor. Work may not be easily queued to a dependent task and its priority is a function of the creating task.

5.2.2.1.2.1 Task Supervision. (Continued)

- (2) Independent Task. This task continues to exist when the task returns to the task supervisor. It may have work requests queued by a priority or queued order (i.e., first-in/first-out; last-in/last-out), and its priority is not a function of the creating task but is assigned with each request to the task. The independent task is a real-time facility used primarily for routing the data received in the RTCC to various applications.
- (3) System Task. This task continues to exist when the task returns control to the task supervisor. Work requests may be ordered on a queued basis and the task priority, assigned during task creation, is not a function of the creating task.

b. Scheduling of Services

- (1) Resource Serialization. The EOS provides enqueue/dequeue routines that allow application tasks to serialize access to a resource. The resource may be one or more data sets, records within a data set, programs, or work areas within main storage. The request may be for shared or exclusive use of the resource.
- (2) Task Dispatching. The TCB describing a task is added to the TCB queue according to the assigned priority of the task. Task dispatching consists of passing control to the highest priority ready task on the TCB queue. The task is allowed to execute until it either completes, is pre-empted by a higher priority task following an interrupt, or must wait for the completion of some event. Supervisory routines go to the task dispatcher following an interrupt when the need is recognized for a task switch.

5.2.2.1.2.1 Task Supervision. (Continued)

- (3) Synchronizing Program Execution. An application may synchronize program execution with the occurrence of one or more events, such as the completion of an I/O operation. Services are provided that stop execution of the requester until the specified events have occurred. Control blocks are then altered so the waiting requester may be placed into execution by the task dispatcher.

5.2.2.1.2.2 Contents Supervision Routines. These routines provide programs for requesting tasks. The contents supervisor determines the location of requested programs, fetches the programs to main storage if necessary, and schedules execution of these programs for the respective tasks.

- a. Locating the Module. A requested module may be in the job step's region of core storage, the link pack area of main storage built during system initialization, buffered in large core storage (LCS), or in a library on an I/O device. Contents supervision routines first search the control blocks describing the modules in the user's region. If the module name is found, the attributes are checked to determine its status. If the module is reusable or reentrant, the existing copy of the module will be used. If the module is not found or cannot be reused, the LCS directory entries are searched for the requested module. These directory entries are built during job step initialization and describe all the modules defined by the JOBLIB/STEPLIB data definition cards. If still not found, the directory entries are read from disk to find the requested module. An additional capability is provided in the EOS that allows a long running application, such as a real-time job, to replace an old copy of a module with an updated copy during execution.

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5.2.2.1.2.2 Contents Supervision Routines. (Continued)

- b. Fetching a Module. The fetching of a module is dependent on where the module was found. If the module is in the job step's region and is reentrant or reusable or in the link pack area, the existing copy of the module will be used. If the module is not reusable or not found in the job step region and appears in an LCS directory entry, fetching is dependent on the status of the directory entry. If a copy of the module is buffered in LCS, it will be moved to the job step region for execution. If the module is not buffered, it will be fetched from disk to LCS and then moved to the job step region. If there is not a directory entry for the module, it will be fetched from disk to the job step region.
- c. Scheduling Execution of the Program. A request block is used to control execution of the module. This request block is pointed to by the TCR or another request block. Contents supervision passes control to the task dispatching portion of the task supervisor when the program has been fetched into executable core and its request block constructed.

5.2.2.1.2.3 Storage Supervision Routines. These routines are responsible for the management of core storage. The storage supervisor allocates main and LCS regions, space within these regions to the application programs, and provides for the dynamic expansion of a region during job execution.

- a. Region Allocation/Management. Job management routines invoke the storage supervisor for a region allocation when scheduling a job for execution. A region request is satisfied with a contiguous area of memory and control blocks are built defining the upper and lower bounds of the allocated region. Storage within the region is dynamically allocated for the application programs and data areas. The storage supervisor further manages the application

5.2.2.1.2.3 Storage Supervision Routines. (Continued)

region by purging programs that are no longer being used when an application requests more core than is currently available. Each allocated block of storage within the region is given the unique protect key of the job. This provides write protection from other jobs executing concurrently in the system.

- b. LCS Management. The EOS provides the application with the capability of dynamically allocating and using LCS memory. The application can specify what load modules and data tables are to be placed on or removed from LCS. A data table is a collection of data required by the real-time job step; it is defined prior to real-time execution and may be shared among programs. In addition, implicit allocation of the modules identified in JOBLIB and STEPLIB data definition statements is performed by LCS management routines during job initialization. Control blocks, used by contents supervision, are built describing the status and attributes of the modules buffered in LCS.
- c. Dynamic Storage Allocation. A long running application may periodically require a larger region than was allocated during job initialization. Dynamic storage allocation routines allow for the temporary expansion and subsequent contraction of an application region thus allocating additional memory only when required.

5.2.2.1.2.4 Termination Procedures. These procedures free the resources and control blocks belonging to the terminating task. There are normal and abnormal termination procedures. Normal termination occurs when the last program to be executed for a task has completed its execution. Abnormal termination occurs when some type of unrecoverable error has occurred and error recovery has not been provided.

5.2.2.1.2.4 Termination Procedures. (Continued)

Normal and abnormal termination differ in their scope of action. Normal termination frees resources only for the completed task, not for its higher level tasks. Abnormal termination allows a step and task termination option. In task termination, the resources of the malfunctioning task and any subtasks are freed. In step termination, the resources used for the entire job step are freed. The freed resources include programs in main storage, enqueued resource requests, incomplete operator requests, unexpired timer requests, exclusively used data sets, and unshared subpools of main storage.

In addition to resource freeing, abnormal termination optionally provides a core image of the job step region. The core image displays major control blocks belonging to the termination task and subtasks and dynamically acquired storage containing data and programs for the task. A trace table is also provided with the core image which displays the service call (SVC), I/O, and external interrupts up to the time of the abnormal termination.

5.2.2.1.2.5 Time Management Routines. These routines process both time interruptions and request for timing services. They enable the programmer to use either the System 360 interval timer or the real-time GMT/MITE time system in performing time dependent functions.

Time management routines are responsible for the initialization and controlling of time scheduled work queues. The application can request that a task be queued work at a particular time of day or at specified intervals of time. With the expiration of the time interval, time routing (using the independent task facility), routes data to the appropriate application task. The GMT/MITE time system is used for measuring the time intervals associated with time scheduled work queues.

The EOS supports the use of the GMT/MITE time system to synchronize the internal clock associated with a real-time job. Multiple machine synchronization, such as the MOC/DSC, is achieved because

5.2.2.1.2.5 Time Management Routines. (Continued)

all the machines are using the same timing source. The application can use the System 360 internal timer to obtain the date and time of day, measure periods of time, or schedule activity for a specific time of day. The real-time application can use the GMT/MITE time system to obtain the current time value for a particular real-time job step or to increment the internal clock by a specified value.

5.2.2.1.2.6 Interrupt Supervisions. The interrupt supervisor is responsible for handling all interrupts for the operating system. The hardware maintains a program status word (PSW), called the current PSW, that contains system status information and the address of the next instruction to be executed. An interrupt consists of storing the current PSW and fetching a new PSW pointing to code for handling the appropriate type of interrupt. All supervisory functions occur only after an interrupt. The various interrupts that can occur in the operating system are as follows:

- a. SVC Interrupt. An SVC interruption occurs as a result of the execution of a supervisor call instruction. An SVC is normally used to switch from application to system mode. There are four types of SVC routines that can be entered as a result of a supervisor call. The action taken by the interrupt handler is dependent on which type of SVC is requested. A Type-1 SVC is resident in main storage and cannot issue any SVC instructions. These routines are entered directly from the SVC First Level Interrupt Handler (FLIH). Type-2 SVC routines are resident in main storage but can issue other SVC requests. They are entered from the SVC Second Level Interrupt Handler (SLIH) after a request block is constructed and queued to the TCB of the calling task. Type-3 and Type-4 routines are normally non-resident. The SVC SLIH builds and queues a request block to the TCB and then passes control to the

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5.2.2.1.2.6 Interrupt Supervisions. (Continued)

transient area fetch routine which loads the requested SVC routine into an available transient area. The SVC SLIH then branches to the task dispatcher which passes control to the now loaded SVC routine.

- b. I/O Interrupt. The I/O interrupt handler provides a means whereby the CPU responds to signals from I/O devices. All I/O interrupts are serviced by the I/O interrupt handler portion of the I/O supervisor which performs any necessary error handling and services.
- c. Program Interrupt. When a program being executed encounters a program check, a program interruption occurs and the program interruption handler is given control. A program check occurs when the hardware cannot respond properly to an instruction. Control is given to the abnormal termination portion of task management for an application program check and to the system recovery facility for a system error.
- d. Machine Check Interrupt. A machine check occurs when the error detection circuitry detects a machine malfunction which it cannot repair. Machine status information is placed in the low core logout area; control is passed to the hardware error recovery portion of the system recovery facility.
- e. The timer/external interrupt handler allows the CPU to respond to interrupts external to the machine, such as the interrupt key, and to handle expired time intervals. The external interrupt handler also recognizes a selectover interrupt requesting a Mission Operations Computer/Dynamic Standby Computer (MOD/DSC) status change. The interrupt handler routes control to the appropriate routine to handle the timer/external interrupt

5.2.2.1.2.7 Console Communication Routines. These routines provide I/O support for one or more console devices. The console communication routines support communication between the operator and application or system programs and maintains a record of the transactions in the system log.

- a. Console Support. Multiple console support is provided by the EOS. Console communication can be initiated by either the operator or the system. The operator enters data or commands into the system through the console typewriter. The console support routines route the commands to the command scheduling portion of job management and the data to the appropriate application or service routine. Output to the console is initiated by an application issuing the console communication SVC. Informational and action type messages can be sent to the console.
- b. System Log. The system log provides a hardcopy of all messages sent to or from the operator's console. This includes application messages, operator commands, system messages, and operator responses to action messages.

5.2.2.1.3 Recovery Management. Recovery management routines attempt to recover from hardware and software failures.

5.2.2.1.3.1 Application Program Recovery. An application program can provide an error routine to be entered when abnormal termination of a specified task is scheduled. The user can either allow abnormal termination processing to continue or can circumvent the scheduled termination and continue program execution.

5.2.2.1.3.2 System Program Recovery. A system program proceeds through error recovery in two phases. The first phase consists of the system recovery facility examining the error. Standard recovery for supervisor program checks involves the repairing

5.2.2.1.3.2 System Program Recovery. (Continued)

of the communication vector table (CVT) pointer in low core. For a real-time job, the major queues and control blocks are examined. If any errors are found, an attempt is made to rethread the invalid control block. In some cases, to ensure system integrity the task will be set nondispatchable.

5.2.2.1.3.3 Hardware Failure. Machine malfunctions, including CPU errors, memory errors, and channel errors, are handled by the system recovery facility. The standard recovery procedure is to isolate the cause of the failure, determine if there was a hard or indeterminant failure, and either abend the task or retry the instruction depending on the type of failure. Channel errors are handled by the channel check handler (CCH) and the System Restart Facility (SRF). If the channel error is type 1, the CCH builds control blocks containing the error information and passes control to the I/O error routines. In the case of type 2 channel errors, SRF intervenes and times out all the devices on the failing channel that had active I/O.

Additional error recovery procedures are provided to support hardware failures on I/O devices outboard of the 360/75. When an error is detected on an I/O device (such as a tape) or a direct access device, the system attempts to switch to a like device to continue processing.

A restart capability is also available for the real-time job to recover from hardware type errors. This capability allows the data contained in one 360/75 to be transferred to another 360/75 over a channel-to-channel adapter.

Software device timeout is an additional capability providing recovery from "lost" I/O interruptions in both a real-time and nonreal-time environment. If an I/O operation takes an abnormal length of time to complete, an interrupt will be generated by timeout, simulating channel end, device end, and unit check.

5.2.2.1.4 Data Management. Data management routines perform operations associated with I/O devices. Data management routines are responsible for system initialization, performing I/O support operation, processing I/O operations, and assigning and releasing space on direct access volumes. Support is also provided for certain real-time devices in the RTCC.

- a. System Initialization. Before the operating system can be used, the nucleus resident portion must be loaded from the system residence volume into main storage and initialized. These functions are performed by the initial program loading (IPL) program and the nucleus initialization (NI) program respectively. The IPL program allows for the scatter loading of the nucleus in main core and large core storage (LCS), determines the size of main storage, computes boundary between main core and LCS, and passes control to the nucleus initialization program. NIP initializes main storage, loads resident modules into the link pack area, initializes console support, and assigns a region to the master scheduler task.
- b. Support Processing for I/O Operations. Support processing for I/O operations consists of open processing, close processing, and end-of-volume processing. Before any information can be read from or written into a data set, open initialization must be performed. This entails ensuring that the required volumes are mounted, constructing control blocks required by the I/O supervisor to initiate the I/O operations, and loading the access method routines that are to process the I/O operations on the data set. The access methods routines provide the application an easy means of communicating with various I/O devices. After I/O operations on a data set are complete, close processing performs label processing, volume dispositioning including the writing of tape marks and positioning of tape reels, and deletes the access method routines.

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5.2.2.1.4 Data Management. (Continued)

- c. Processing I/O Operations. The actual processing of the I/O operation involves starting the I/O and terminating the I/O. The I/O operation is started via a particular SVC interruption which gives CPU control to the I/O supervisor. The I/O supervisor either starts the I/O to the device or queues the I/O request if the device is currently busy. An I/O interruption occurs when an I/O operation terminates. The I/O interrupt handler passes control to the interruption portion of the I/O supervisor. The I/O supervisor posts the completion of the I/O operation, schedules error routines when the operation terminates abnormally, and, if possible, starts another I/O operation on the channel. CPU control is returned to the I/O interrupt handler.
- d. Direct Access Storage Device Management. The assigning of direct access space is performed by the direct access device space management routines of data management. These routines are used primarily by job management routines during job step initialization to obtain space for output data sets. The allocation of space is controlled through the volume table of contents (VTOC) of the requested volume. The VTOC, which indicates the current usage of space on the volume, is updated by the direct access management routines when space is assigned or released.
- e. Real-Time Data Management. The EOS provides a means of controlling data transmission to the real-time devices in the RTCC. These include the digital television equipment (DTE), digital displays, plotting displays, manual entry devices (MED's), and extended Ground Support Simulation Computer (GSSC) and ALSEP interfaces. The real-time data management routines provide an efficient, high performance access to these nonstandard devices without using

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5.2.2.1.4 Data Management. (Continued)

the standard data management features of the operating system. A real-time logging capability is supported that provides a log of data transmissions for the real-time job. A formatting language is provided that converts application output to the display devices into the required format for the particular device. Real-time data management routines also provide a means of simulating real-time inputs.

5.2.2.1.5 Interface Support. The EOS provides support for nonstandard devices and interprocessor communications. Basic level support is provided for the nonstandard devices used in the RTCC. This support allows more than one application to share access to a device and provides communication between the 360/75 and the CYBER and UNIVAC computers.

Interface support is based on the concept of sharing a device that is normally not sharable between two or more applications executing concurrently. Shared support is provided for the UNIVAC 494 and the DTE interface including Computer Input Multiplexer (CIM) and ALSEP Computer Input Multiplexer (ALCIM). The interprocessor message exchange (IME) interface is also supported.

5.2.2.1.6 Program Development and Maintenance Support. Language support and program management systems facilitate program development. The EOS provides support for the majority of programming languages and supports a program management system to simplify program development and maintenance.

- a. Language Support. The language support programs provided by the EOS includes the Assembler F and Assembler H V5.0, the FORTRAN G and H compilers, and the FORTRAN library, the PL/I compiler and PL/I library, the COBOL compiler, RPG, the linkage editor, and the loader.

5.2.2.1.6 Program Development and Maintenance Support. (Continued)

- b. Program Maintenance. The EOS supports a program management system designed to facilitate development and maintenance of large programming systems containing both source and load module data sets. This system compresses source programs, merges update cards, invokes the specified language support processor for each program being modified, link edits a load module using the updated programs, outputs the load module for trail execution, and optionally produces a collection tape containing the update information which is used as input to the system build.

5.2.2.1.7 Utilities. Utility routines assist programmers and operators in the usage of the computing system. The utility programs assist in organizing and maintaining data, operation of the computing system, and the generation of the operating system.

5.2.2.1.7.1 Operator Utilities. The operator utilities aid in the operation of the computing system. The utilities include, but are not limited to, the dumping and restoring of direct access to and from tapes, the erasing of direct access devices, copying tapes, reproducing card decks, and background printing of system output tapes to printers. In addition the operator can direct system output to tapes for later printing and can dump the records describing jobs to be processed by the system to a tape to be read at a later date and processed.

5.2.2.1.7.2 Application Utilities. The utilities provided for application usage are primarily in the area of organizing and maintaining data. The utilities can be used to copy data sets from disk to tape or tape to disk, copy data sets between direct access volumes selecting all or certain members, compress data sets, and scratch data sets that are no longer needed.

5.2.2.1.7.3 System Generation Utilities. System generation is a process that generates an operating system adapted to both the machine configuration and the data processing requirements of an installation. Utilities are provided that facilitate the system generation process. These utilities perform volume initialization for the system/residence volume, allocating and cataloging of the system data sets, and transferring of system modules from tape to the system residence volume.

5.2.2.1.8 Programmer/System Aids. The EOS supports interactive programming, checkpoint/restart, system monitoring, and system management capabilities that assist the application and systems programmers in the performance of their jobs.

- a. Interactive Programming. The time sharing option adds general purpose time sharing to the facilities of the MVT control program by enabling users at remote terminals to execute programs concurrently and to interact with these programs during execution.
- b. Checkpoint/Restart. The checkpoint/restart facility allows a job to be restarted after an abnormal termination. The retry can begin at the start of a job or within a job step, and prior steps and portions of a step can be skipped if they are executed successfully. This facility is also useful for long running applications which can interrupt their processing and complete processing at some other time from the point of interruption.
- c. System Monitoring. The EOS supports a statistic collection tool providing timing information and frequency statistics to the application and system programmer. A user can obtain CPU statistics, load module statistics such as execution timings and percent of CPU utilized, task statistics for a summary of task activity, I/O device statistics for a summary of device utilization, data set statistics, and core storage statistics.

5.2.2.1.8 Programmer/System Aids. (Continued)

- d. System Management. System management facilities gather and record information used to evaluate system, data set, and direct access volume usage. This consists of recording system wait time, counting the number of references to user data sets, and recording the amount of storage used within the applications allocated region. The system management facility also provides user exits for job and step time limit expirations and the output limit for system output data sets.

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5.2.3 Terminal Control System (TCS) Computers. To be provided.

5.2.4 Data Base Subsystem. To be provided.

5.2.5 Orbital Flight Test/Operations (OFT/OPS) Transition.
To be provided.

5.3 Telemetry Preprocessing Computer (TPC) Software. The TPC software shall consist of real-time telemetry preprocessing software, systems software, systems test software, and reconfiguration software. The real-time software shall be capable of accepting two telemetry downlinks simultaneously. The valid combinations of Orbiter and Payload downlinks are shown in table 4.

The software shall incorporate all the functions necessary to provide a generalized decommutation service for a wide variety of telemetry formats. The Shuttle OD data shall be preprocessed according to various downlink characteristics. The telemetry preprocessing software shall be table driven to minimize mission-to-mission reconfiguration time.

5.3.1 Telemetry Preprocessing Software. Telemetry preprocessing shall consist of the total set of program modules (tasks) which perform all functions related to the input, validation, special data processing, reformatting, and output of data derived from the single downlink input to the TPC by the Network Communications Interface (NCI). These tasks shall be totally memory resident and shall operate at the highest application task priority level available in the system. Each task shall be assigned a unique priority for the purpose of sequencing the order of execution. A functional block diagram of the telemetry preprocessing task is shown in figure 47. If required due to timing considerations, the telemetry preprocessing tasks or portions thereof shall operate in a "privileged" mode of execution to allow direct control of interfaces and/or peripheral devices which might otherwise be controlled by the Real-Time Operating System (RTOS) in a less time critical environment.

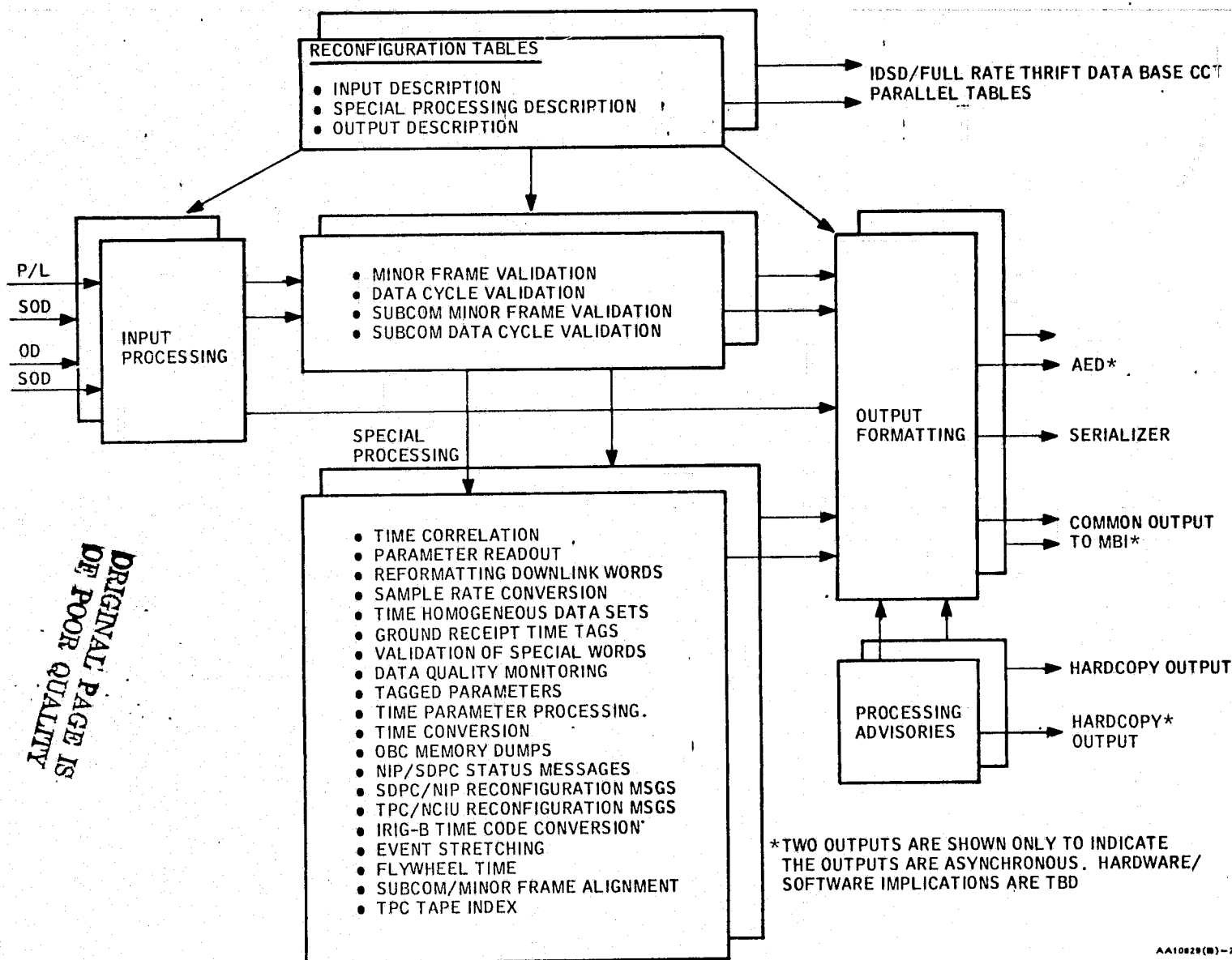
The telemetry preprocessing tasks shall be table driven to the maximum possible extent. There shall be one set of process control tables required for each format which can be downlinked during a specific mission. These table sets shall reside on a mass storage device such as a disk unit(s) and shall be accessible by the TPC operational program at any time. The tables required for processing of the downlink format currently being input shall

TABLE 4.
 VALID DOWNLINK COMBINATIONS

TPC INPUT CONFIGURATION		ANALOGS	HIGH RATE EVENTS	LOW RATE EVENTS	SDPC BYTES/SEC	IDSD, DB HIGH RATE DELOG KB/S	SERIALIZER KB/S
1	128 KB/S OR 64 KB/S OD AND ONE PAYLOAD @ ≤ 64 KB/S	160 @ 100 S/S 40 @ 100 S/S	50 @ 100 S/S 10 @ 100 S/S	350 @ 10 S/S 30 @ 10 S/S	2500 OR 1250 1250	128 OR 64 ≤ 64	COMBINED RATE NOT TO EXCEED 1 MB/S
2	PAYLOAD 1 @ ≤ 64 KB/S PAYLOAD 2 @ ≤ 64 KB/S	40 @ 100 S/S 40 @ 100 S/S	10 @ 100 S/S 10 @ 100 S/S	30 @ 10 S/S 30 @ 10 S/S	1250 1250	≤ 64 ≤ 64	
3	128 KB/S OR 64 KB/S OD	200 @ 100 S/S	50 @ 100 S/S	350 @ 10 S/S	2500 OR 1250	128 OR 64	NA
4	PAYLOAD @ 64 KB/S ≤ 1 MB/S	40 @ 100 S/S	10 @ 100 S/S	30 @ 10 S/S	1250	NA	NA

NOTE: PARTITIONING OF ANALOGS AND EVENTS IS CURRENTLY UNDERGOING REVIEW.

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Figure 47 Telemetry Processing Task Functional Block Diagram

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5.3.1 Telemetry Preprocessing Software. (Continued)

be memory resident. The real-time reconfiguration task shall be required to input these tables. If the required tables are not memory resident upon detection of an A/G downlink format change, a request shall be made to the real-time reconfiguration software for the loading of the required set of tables. In this case the processing tasks shall be suspended until all tables are loaded and the required hardware/software reinitialization has been completed. The maximum time for reconfiguration due to A/G format change shall be 15 seconds. Processing shall be reinitiated at the beginning of a data cycle. Advisory messages shall be generated and queued for output containing relevant information concerning the format change.

The real-time interrupt processor gains control and reinitiates the NCI to continue. It also schedules the minor frame processor through the RTOS. Minor frames are multibuffered. When the NCI has completed the transfer of an A/G minor frame to the TPC, a minor frame input complete interrupt is generated. The minor frame processing task gains control under a high system priority and commences the minor frame processing. As each minor frame is validated it is mapped into intermediate data cycle buffers by the minor frame/data cycle mapping task. The minor frame validation and mapping tasks shall be reentrant in order to handle the case of near simultaneous minor frame interrupts.

When a complete data cycle has been collected, a request shall be made for the data cycle processing task. The criteria for data cycle validation are conditional and may be selectively enabled or disabled through the manual input task. The telemetry output task shall be notified that the data is available from the intermediate storage for output when the data cycle has been validated. The output products task shall use control tables which describe and control the building of the output products.

The support tasks such as manual input, logging, real-time reconfiguration, display, advisory processing are scheduled as required by the system software.

5.3.1 Telemetry Preprocessing Software. (Continued)

The Shuttle Carrier Aircraft/Simulation Trajectory Data Interface (SCA/SSD) and BDF header processing are interrupt driven by the NCI in a manner similar to real-time telemetry tasks.

All tasks in the system shall communicate through an area of memory designated as task common. Task common shall contain all buffers, flags, and intertask communication queues. All tasks shall have read/write access to task common and all intertask communication shall conform to standard RTOS guidelines. Should direct communication between tasks become necessary due to timing constraints, and this feature is not standard in the vendor RTOS, the RTOS shall be modified to provide this capability.

5.3.1.1 Input. The input of dual link telemetry data shall be performed asynchronously. OD data shall be input on a minor frame basis. Site originated data for the OD data shall be input asynchronously at a one per second rate. Input processing shall consist of the following functions:

- Input status accounting
- Minor frame validation
- Minor frame routing
- Minor frame accounting
- Subcommunication frame/data cycle validation
- Data cycle validation
- Adjusted ground receipt time tagging for Orbiter downlink (OD).

5.3.1.2 Processing. The telemetry data shall be processed on a data cycle basis to satisfy the following process functions:

- a. Time correlation of OD and General Purpose Computer (GPC) data
- b. OI/GPC reordering
- c. Special processing functions
 - Parameter value readout
 - Reformatting of selected downlink words
 - Sample rate reduction
 - Time homogeneous data set processing
 - Validation of special data sets
 - Tagged parameter processing
 - Conversion of onboard times
 - GPC main/mass memory dumps
 - NIP/SDPC status message
 - SDPC/NIP reconfiguration messages
 - TPC/NCI reconfiguration messages
 - Time output to IRIG time code converter
 - Flywheel times
 - Subcommunication to minor frame alignment
 - Time correlation
 - Data quality monitoring
 - Event stretching
 - TPC tape index
 - Ground receipt time tagging.

5.3.1.3 Output Processing and Formatting. The TPC shall output formatted data to the following MCC elements:

- SDPC
- IDSD
- High rate delog (same physical product as IDSD tape)
- Data base (OPS era only)
- Analog and Event System
- Serializer

In addition, the TPC outputs status and accounting data to SDPC IRIG B converter data, and TPC operators Cathode Ray Tube (CRT) for statusing.

5.3.2 System Software. The NIP minicomputer system shall include a real-time operating system, standard assembler(s), FORTRAN IV, and basic utilities (diagnostics, text editor, math libraries, etc.). The real-time operating system shall provide peripheral access methods, job control, error recovery, external time synchronization, etc. The system software is to be procured with the computer system as standard vendor supplied products. It is anticipated that minor modifications shall be required to the real-time operating system to provide the required NIP support.

The system software shall support the TPC defined in procurement specification SP-25838. The software shall fully support all hardware described in paragraph 4.2. System software shall be off-the-shelf and will support the maximum memory procured. Software capabilities shall be as follows:

a. Real-Time Operating System

(1) Operator function

- Device assign/release

5.3.2 System Software. (Continued)

- Job initiate/suspend/terminate
- Load/execute program from library
- (2) Program services
 - Time of day, data
 - Logical I/O assignment
 - Operator communication
 - Multiple sequential files on a single disk
- (3) General
 - Support real-time operations from disk
 - Interrupt linkage time of less than 10 microseconds
- (4) Loader
 - Relocatable linking loader (link editor)
 - Overlay preparation program
 - Load map and diagnostics
 - Undefined references resolved from library
- (5) Configuration support
 - Drivers for all devices
 - Real-time clock support
 - Full memory utilization

5.3.2 System Software. (Continued)

(6) Real-time support

- Simultaneous multitasks initiated from disk or main memory by hardware interrupt, call from another task (including parameter transfer), timer scheduling
- Reentrant programs used by multiple real-time tasks
- Task priority
- Interrupt priority
- Noncontiguous memory space management
- Self suspension of tasks until a specified time has elapsed and/or called by another task

b. Assembler

(1) Syntactic form

- Machine language mnemonics
- Free field definition
- Arbitrary length address expressions

(2) Directives (base, if applicable)

(3) Macros

- Name substitution
- Local identifiers

5.3.2 System Software. (Continued)

(4) Data structures

- Hexadecimal, octal, decimal and character constants
- Hexadecimal, octal, decimal, harlequin, and identifier literals
- Partial word definitions

(5) Outputs

- Assembly listing
- Diagnostics
- Relocatable binary
- Cross-reference listing. -

5.3.3 System Test Software. The NIP test software shall be capable of exercising all system interfaces. The diagnostic software concept is based on developing unique interface exercisor for each interface. The individual interface exercisors shall be integrated into a single diagnostic system. The diagnostic system shall be capable of causing individual exercisors and multiple interface exercisors to be executed simultaneously. Each diagnostic test shall be designed consistent with the following guidelines:

- Test all features of interface
- Provide advisory capability for rapid fault isolation
- Fault isolation accomplished to the component level where possible

5.3.3 System Test Software. (Continued)

- Modular in design to facilitate integration
- Capable of execution in a multitask environment.

The diagnostic tests fall into the category of vendor supplied or SISO developed.

The vendor supplied diagnostics shall have the following characteristics:

a. Diagnostics

(1) CPU and memory tests

- Test all memory and all instructions
- Test all CPU elements

(2) Options tests

- Computer options
- I/O options

(3) Peripherals, I/O interface tests

- Locate errors as to interface or peripheral
- Test all peripheral devices addressed in support operations wing (SOW)

b. Debug software

- (1) Examine/alter/list memory and register content
- (2) Search for specific conditions

5.3.3 System Test Software. (Continued)

(3) Transfer data from:

- Memory to memory
- Memory to magnetic tape
- Memory to printer
- Memory to disk

(4) Set multiple breakpoints

(5) Trace program execution of debug commands

The system interface tests shall include:

- NCIU control interface test
- OD data interface test
- SOD data interface test
- AT/BDF statistics interface test
- MITE interface test
- IRIG interface test
- Hazeltine 2000 interface test

5.3.4 Reconfiguration System. The reconfiguration of TPC software is accomplished by the loading of offline generated tables. The tables are generated by a 2-step process. Step 1 is the generation by the SDPC, in TPC assembler source form, of all data necessary to define the loadable tables. In step 2, the source data is assembled at the TPC (offline) to produce the loadable tables.

5.3.5 OFT OPS Transition. To be provided.

6. DCC APPLICATION SOFTWARE

The DCC application software writeup is provided by IBM under separate cover titled *Mission Control Center (MCC) System Specification for the Shuttle Orbital Flight Test (OFT) Timeframe, Section 6.*



7. TESTING AND CHECKOUT

7.1 General. This section describes the hardware and software tools which shall be provided to test and checkout MCC functions. Included are definitions of terms used as well as how the various test and checkout requirements shall be met. General test and checkout categories include hardware, software, and validation testing.

7.2 MCC Readiness Testing. MCC mission readiness testing is defined as execution of those tests required to verify MCC mission support capability. Readiness testing is a procedural execution of specific tests such as phase modulation (PM), subsystem, system, and validation tests. These tests are considered to be tools that can be selected and executed as appropriate to demonstrate MCC support readiness for a particular type mission. A mission readiness test plan shall be prepared for each mission defining the tests required and test sequence. Testing tools selected for readiness testing should vary as a function of the following.

- Time between missions
- Modifications to hardware/software between missions
- Changes in Shuttle flight hardware/software
- Changes in support requirements
- Extent of reconfiguration between missions.

Reference figure 48 which shows mission readiness testing activities leading up to OFT flight No. 1.

Table 5 shows the interrelationship between the various categories of hardware, software, and validation tests.

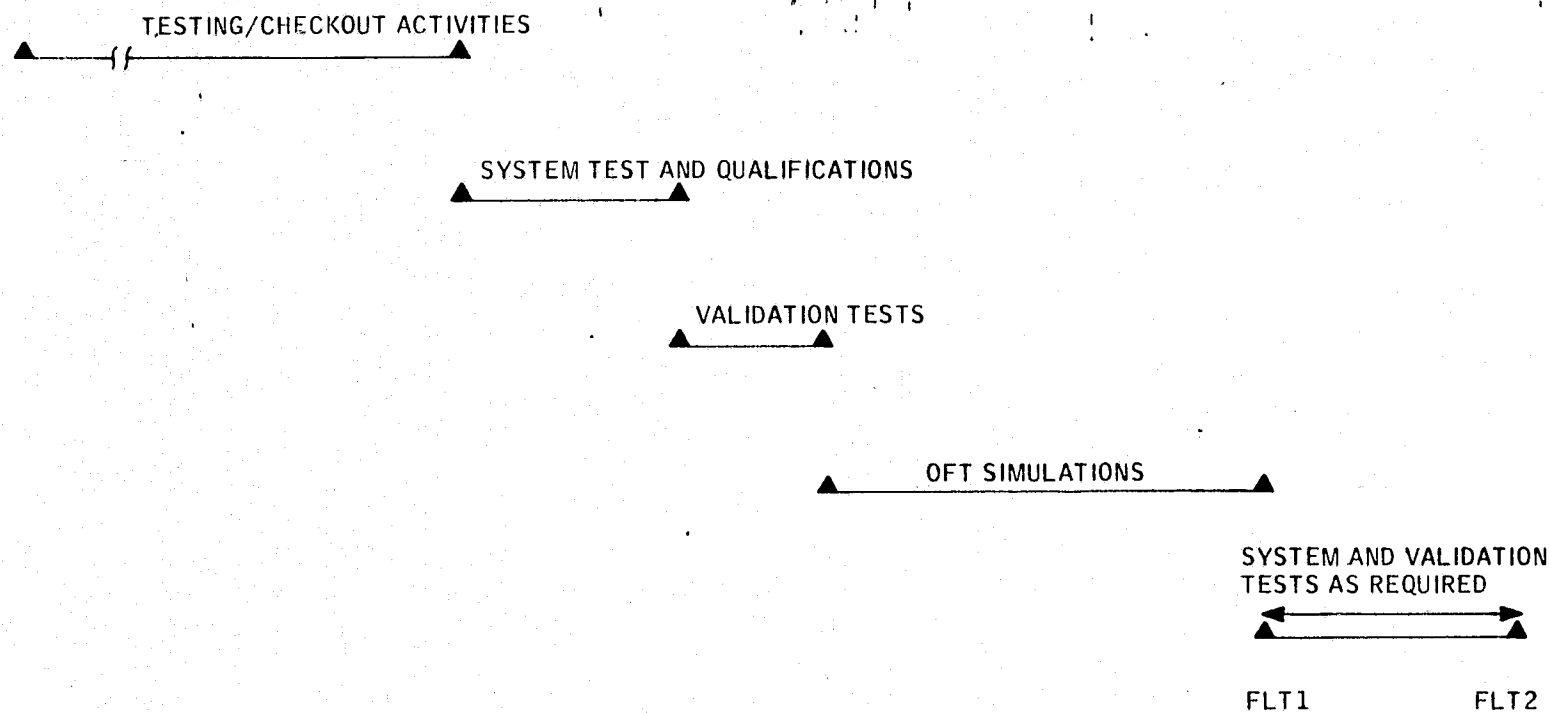


Figure 48 OFT Testing/Checkout Activities During OFTDS Implementation

TABLE 5
INTERRELATIONSHIP OF TESTING/CHECKOUT CATEGORIES

CHECKOUT TESTING	HW TEST TO SPECS	HW I/F TESTING	HW INTEGRATION TEST	SW MODULE TEST	SW SUBROUTINE TEST	SW SYSTEMS TESTING	SW SYSTEMS ACCEPTANCE	SW SYSTEM LOADING	HW SYSTEM LOADING	NETWORK I/F VERIFICATION	SW SYSTEMS INTEGRATION TEST	CONFIGURATION VERIFICATION	TOTAL MCC C/O
HW PREVENTIVE MAINTENANCE	X												
HW UNIT LEVEL	X											X	
HW SUBSYSTEM LEVEL		X	X									X	
HW SYSTEM LEVEL		X	X									X	
SW UNIT LEVEL				X									
SW SUBSYSTEM LEVEL				X	X								
SW SYSTEM LEVEL				X	X	X	X	X			X	X	
SW DEVELOPMENTAL TESTING				X	X								
SW INDEPENDENT VERIFICATION TESTING				X	X	X	X	X			X	X	
ACCEPTANCE TESTING	X						X						
QUALIFICATION TESTING	X	X	X				X	X	X		X		
VALIDATION TEST NETWORK										X			
VALIDATION TEST MCC END-TO-END		X	X					X	X		X	X	X
MCC READINESS TESTING	CAN APPLY TO ALL CATEGORIES												

7.3 Software Test/Checkout and Verification

7.3.1 Definitions. Two sets of definitions for software test and checkout are provided since both sets of terminologies shall be in common use during Shuttle mission. In general, the first set is applicable to small and medium scale computer systems and the second, to large scale computer systems. Both sets of definitions have a large degree of commonality; however, there are a few distinct differences which re-enforce reasons for retaining two sets rather than developing one set of common definitions.

7.3.1.1 Small and Medium Scale Computer Systems Definitions. The following definitions of software testing are commonly used to describe checkout and test of software on small and medium scale computer systems. These definitions are consistent with top-down methodology of software development and testing. The definitions provided cover testing elements of code without regard to phasing or system execution sequence. Overall testing goal is to develop and integrate elements of code into the system in a manner that is consistent with the operational environment in order to minimize interface and timing problems.

- a. Software Element Testing. Software element testing is processing oriented rather than logic oriented; logic processing is defined as the data flow decisions between elements. Element testing verifies correct operation of software elements within defined input data boundaries and throughput operation for data outside of legitimate input data boundaries.
- b. Software Subsystem Testing. A test which is related to a major program function and includes testing of both logic responses and linkage between program elements within that function. Subsystem testing verifies that program stimuli are properly interpreted and that related processing is correctly initiated and operated. It also verifies that table structures and communication registers are compatibly implemented.

7.3.1.1 Small and Medium Scale Computer Systems Definitions.
(Continued)

- c. Software System Testing. Software system testing combines all program functions, measures critical program response times, and tests both system level logic response and linkage between program subsystems. This level of testing also verifies that required program loading can be accomplished without violating specified program response times. It also completes the logic and linkage testing started during element testing.

7.3.1.2 Large Scale Computer Systems Definition. The second set of definitions which follow are primarily related to checkout and test of software used on large scale computer systems. This set of definitions is applicable to any software testing and checkout system where top-down development methods are utilized.

- a. Software Development Top-Down. All ground based system applications to be executed in the large scale computers will be developed with the top-down approach. Top-down development consists of sequencing the development of elements of code in the order in which those elements are to be executed. This minimizes elements interface problems, integration problems, and development of throwaway code, while it maximizes management control.
- b. Software Development Testing. Through the use of top-down development the system architecture is available early in development; therefore, programmer testing of newly coded modules is done in a system environment. Once it is established that the high level system control program works, problems in newly coded programs can be easily detected. Code is tested in a temporary update mode prior to placement on the system disk pack. Development testing is an ongoing test by development programmers through the development phase and is requirements oriented.

7.3.1.2 Large Scale Computer Systems Definition. (Continued)

- c. Software Independent Verification Testing. Independent verification complements development testing discussed in the preceding paragraph. It is requirements oriented and is used to certify the functional requirements of the software applications. It consists of system level testing in both the batched mode and scheduled mode of program execution. Independent verification testing is accomplished by software program analysts who are user oriented and trained in analysis of requirements and application programs.

7.3.1.3 Other Pertinent Definitions. The following definitions have been included to clarify the use of these words in this document.

- a. Data Generator. A computer output programmed to provide timed data sequence(s) including real-time which can be used as a data source for checkout purposes or logged to provide a direct confidence tape build capability.
- b. Script Tape. A tape containing data designed specifically to control the data generator output to provide a dynamic text sequence for checkout support. The same script tape will control auto-sequence or semi-autosequence.
- c. Autoscoring. Comparison (software processing checkout results) reduced to a GO/NOGO magnitude; i.e., errors only test error summary or the processing of a specific tape or disk to produce an output in terms of test results. A visual output indicating errors per data cycle and pertinent test status is required.
 - (1) Real-time (online) is defined as a single pass process in which the scoring output is done in real-time as the test progresses.

7.3.1.3 Other Pertinent Definitions. (Continued)

- (2) Near real-time (offline) is defined as a two-pass process in which certain specific data is written to tape, disk, or drum as the real-time test sequence progresses and is available for reduction to the desired level (usually same as above) immediately following the termination of test sequence.
- d. Closed Loop Test. A configuration in which the generator and the comparison elements of the system are connected to provide all necessary synchronization required for test scoring.
- e. Open Loop Test. A configuration in which the only connection between the data source and the comparison system is the data to be scored.

7.3.2 Software Testing/Checkout Plan for Major Computer Systems: The following paragraphs describe the baseline plan for accomplishing software test and checkout of Shuttle OFT support during development, integration, and system testing. Also included are requalification testing after modification and/or reconfiguration. Systems described include the NIP, SDPC, and 360/75.

7.3.2.1 NIP System Software. Testing and checkout of the NIP/TPC software shall be accomplished using prerecorded telemetry confidence tapes as a test data source and offline autoscoring to evaluate TPC processing results.

The prerecorded wideband (WB) telemetry confidence tapes will be generated by the U418 Generalized Confidence Tape System (GCTS). The U418 GCTS will be modified to provide capability to produce multisite, interleaved multiformat A/G and dump telemetry (TLM) data in 1.544 Mb BDF form. Offline scoring of TPC outputs will be accomplished using GCTS scoring capability. The GCTS will be modified as required to add offline autoscoring capability.

7.3.2.1.1 Test and Checkout Operation. During test and checkout operation, 1.544 MB BDF WB confidence tape data will be input to the NIP/TPC. After test data has been input to the system, NIP/TPC outputs to the analog event drivers (AED), Institutional Data Systems Division computer compatible tape (IDSD CCT), and multibus (MBI) will be logged on CCT's. Output log tapes shall be transported to the GCTS for offline scoring and subsequent evaluation. The same basic process will support testing/checkout for development, integration, and systems testing, as well as software requalification testing. Reference figure 49 for block diagram of NIP/TPC in test configuration.

7.3.2.1.2 NIP/TPC Functional Processing Requirements. NIP/TPC functional processing requirements to be validated during test and checkout include the following:

a. TPC Inputs

- (1) Input status accounting
- (2) Minor frame validation
- (3) Minor frame routing
- (4) Minor frame accounting
- (5) Subcommunication frame/data cycle validation
- (6) Data cycle validation
- (7) Adjusted ground receipt time tagging

b. TPC Processing

- (1) Time correlation of OD and GPC data
- (2) OI/GPC reordering

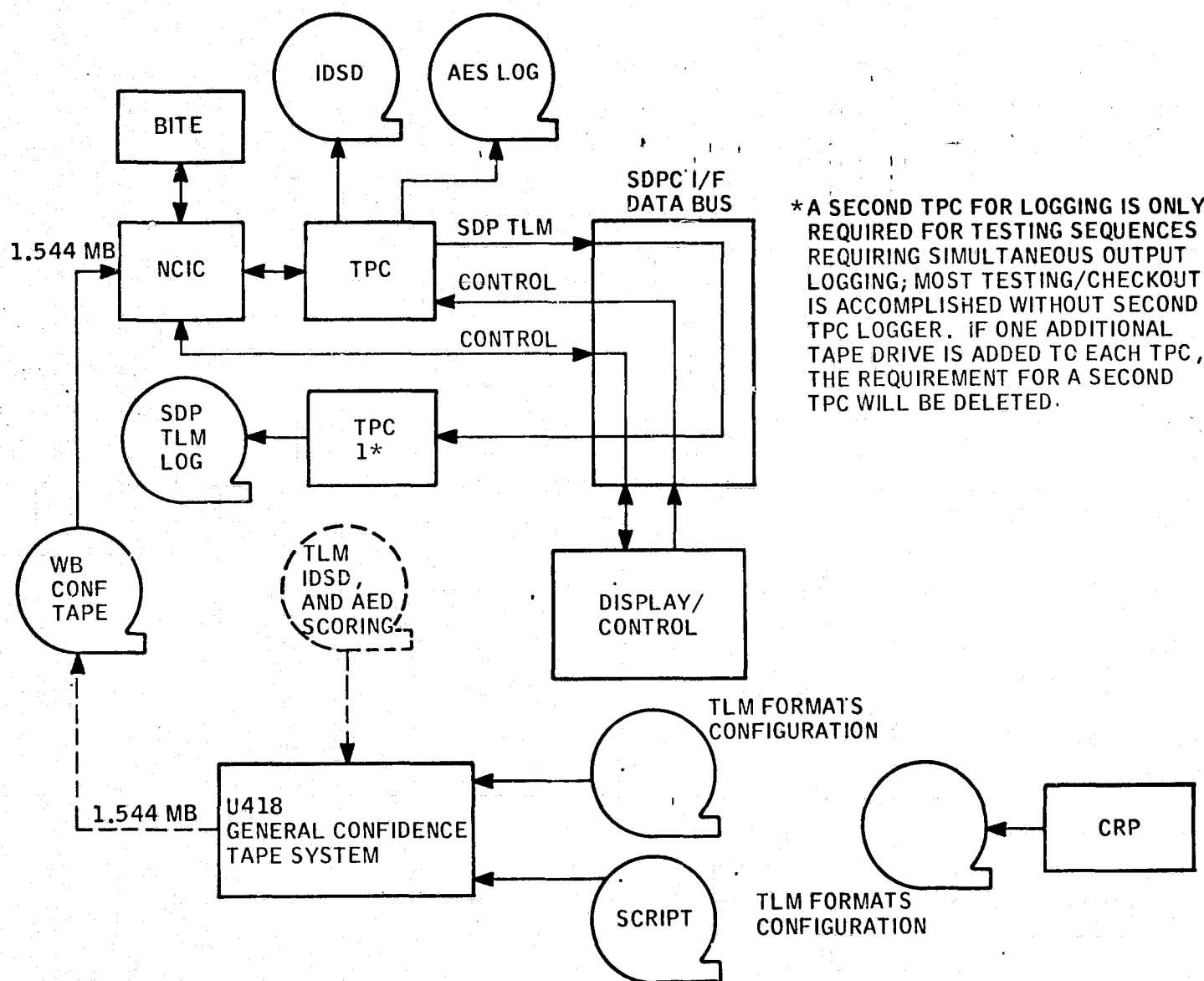


Figure 49 NIP Checkout/Testing Configuration

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7.3.2.1.2 NIP/TPC Functional Processing Requirements. (Continued)

(3) Special processing functions

- Parameter value readout
- Reformatting of selected downlink words
- Sample rate reduction
- Time homogeneous data set processing
- Validation of special data sets
- Tagged parameter processing
- Conversion of onboard times
- GPC main/mass memory dumps
- NIP/SDPC status message
- SDPC/NIP reconfiguration messages
- TPC/NCI
- Time output to IRIG time code converter
- Flywheel times
- Subcommunication to minor frame alignment

c. TPC outputs

- (1) SDPC
- (2) High rate delog
- (3) Data base (OPS era only)

7.3.2.1.2 NIP/TPC Functional Processing Requirements. (Continued)

- (4) IDSD
- (5) Analog and Event System
- (6) Serializer

In addition, the TPC outputs status and accounting data to the SDPC and the TPC operator's CRT for statusing and to the IRIG-B converter.

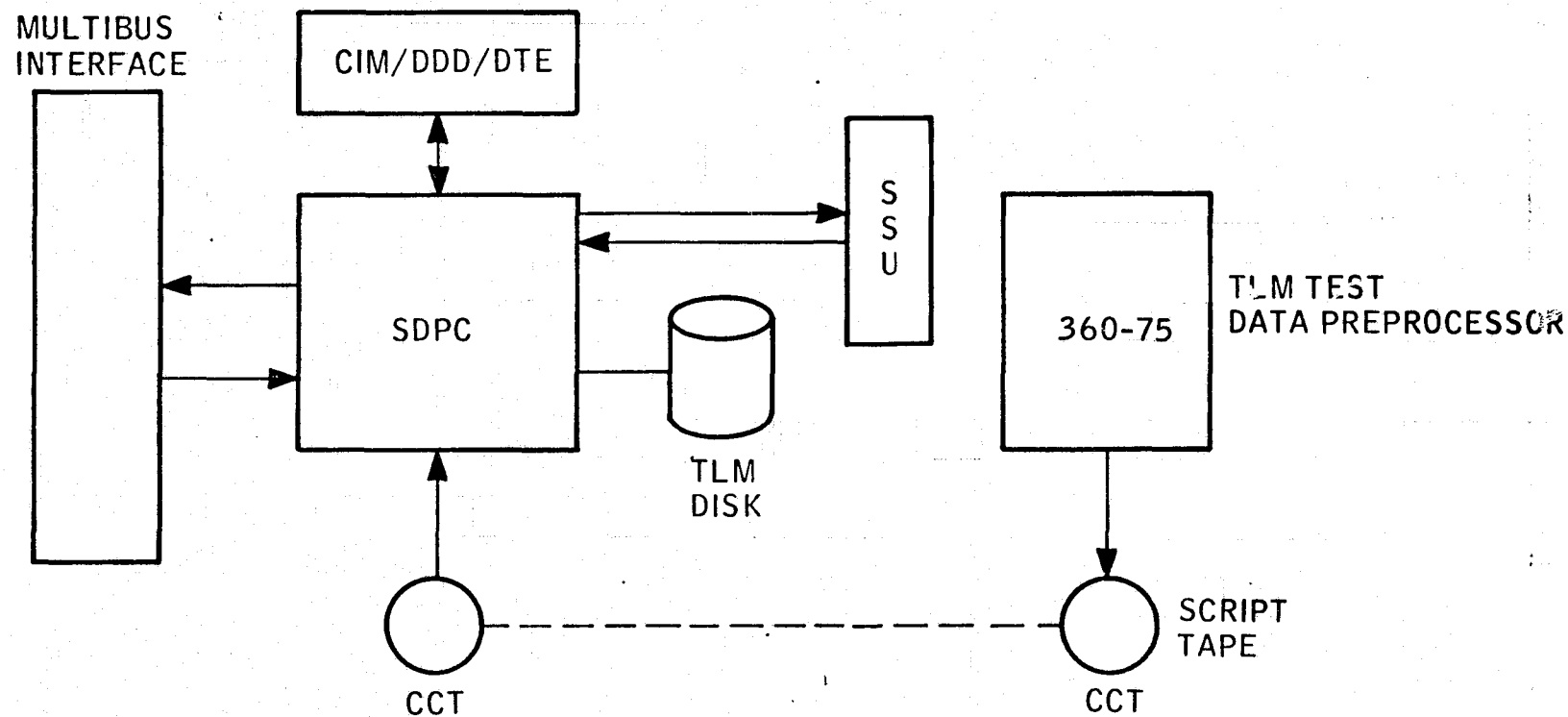
7.3.2.1.3 TPC OS Testing. The TPC software shall be tested to the extent necessary to prove the OS vendor supplied software. The plan for testing of the TPC OS is to be provided.

7.3.2.2 SDPC System Software. Testing/checkout of the bulk of SDPC OFTDS applications software shall be accomplished by use of an online data generator for program stimuli. Program performance evaluation shall be accomplished by autoscoreing outputs. Some outputs shall be scored offline and/or manually.

The SDPC software test and checkout system shall be designed to support multijob batch mode testing as well as online interactive support. Batch mode testing shall be the primary mode used during program development and shall be used to accomplish approximately 78 percent of software testing during this period. Reference figures 50 and 51 for SDPC hardware configuration and data flow during software checkout.

SDPC software checkout program shall operate in a coresident mode and shall support multijob testing. Applications software to be tested under SDPC OFTDS category are as follows.

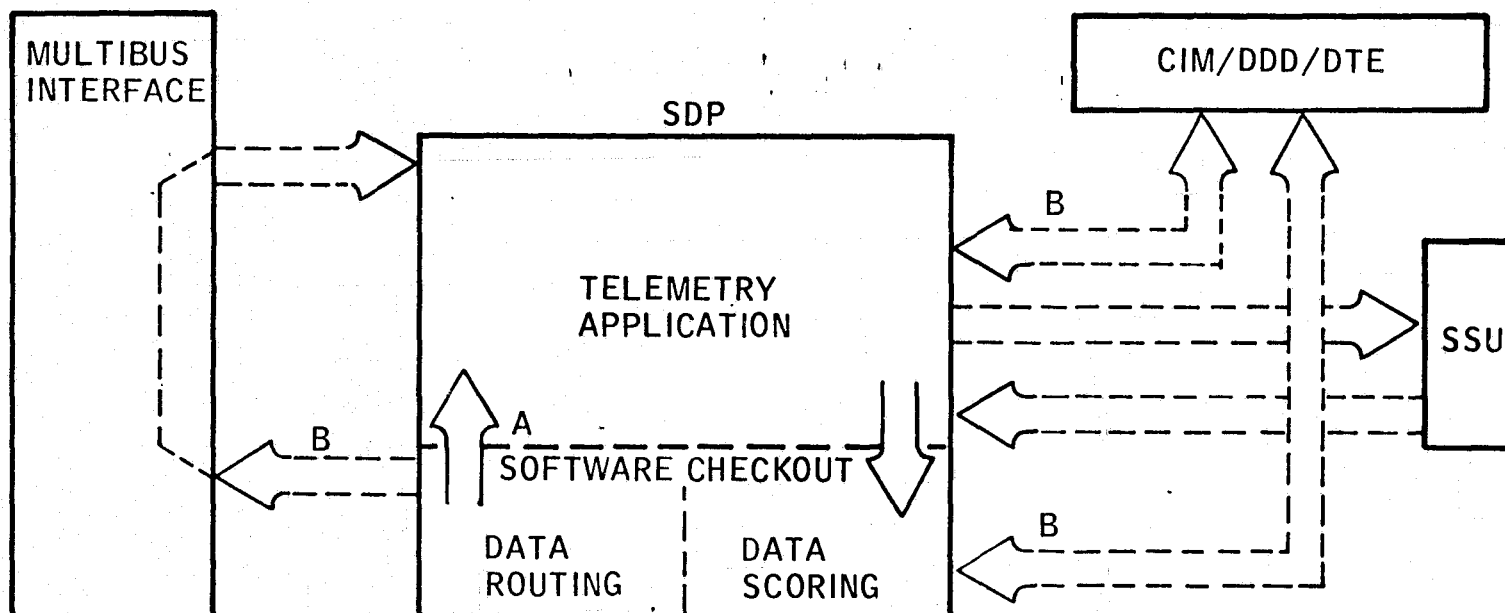
- CCS telemetry and control
- CCS network communications (NETCOM)
- TCS



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Figure 50 SDPC Hardware Configuration for Software Checkout



- A - SINGLE JOBSTEP "BATCH MODE"
 SOFTWARE CHECKOUT DATA IN CORE ROUTE TO TELEMETRY APPLICATION WITH DATA SCORING ON IDA.
- B - MULTIJOBSTEP OR MULTICOMPUTER
 SOFTWARE CHECKOUT DATA ROUTED TO HARDWARE INTERFACE AND LOOPED BACK TO APPLICATION WITH DATA SCORING ON RESULTS. EXAMPLES OF TEST ARE SYSTEM PERFORMANCE TEST AND OS ACCESS METHOD TEST.

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Figure 51 SDP Software Checkout Data Flow

7.3.2.2 SDPC System Software. (Continued)

Checkout and test software shall be designed and implemented in such a manner that selected subsets can be utilized for MCC validation testing. Scoring software shall be capable of operating in the open loop mode; i.e., has the ability to synchronize with test sequence identification (ID) words in the input test data where practical.

7.3.2.2.1 SDPC Data Generator. The SDPC data generator shall be designed to use basic telemetry test data generated in a preprocess step on the 360/75 as a base for presentation to the application programs. Header data, data faulting, and data overrides shall be accomplished in the data presentation phase of the software checkout function. Command control input and response shall be generated during test execution. The data generator shall be designed to be controlled by cards as well as MED's for batch mode and scheduled time testing.

7.3.2.2.2 Data Scorer. The SDPC data scorer shall be designed for both online and offline scoring. Some scoring shall be performed manually. Where cost-effective, autoscoring shall be used. Regardless of the scoring method used, the design goal is to provide test results in nearreal-time.

7.3.2.2.3 SDPC Functions Tested. SDPC functions tested shall include all SDPC functions listed in section 6 published under separate cover by IBM.

7.3.2.2.4 SDPC OS. SDPC OS software shall be tested to demonstrate and prove capability to provide support requirements. Testing/checkout methods for OS are to be determined.

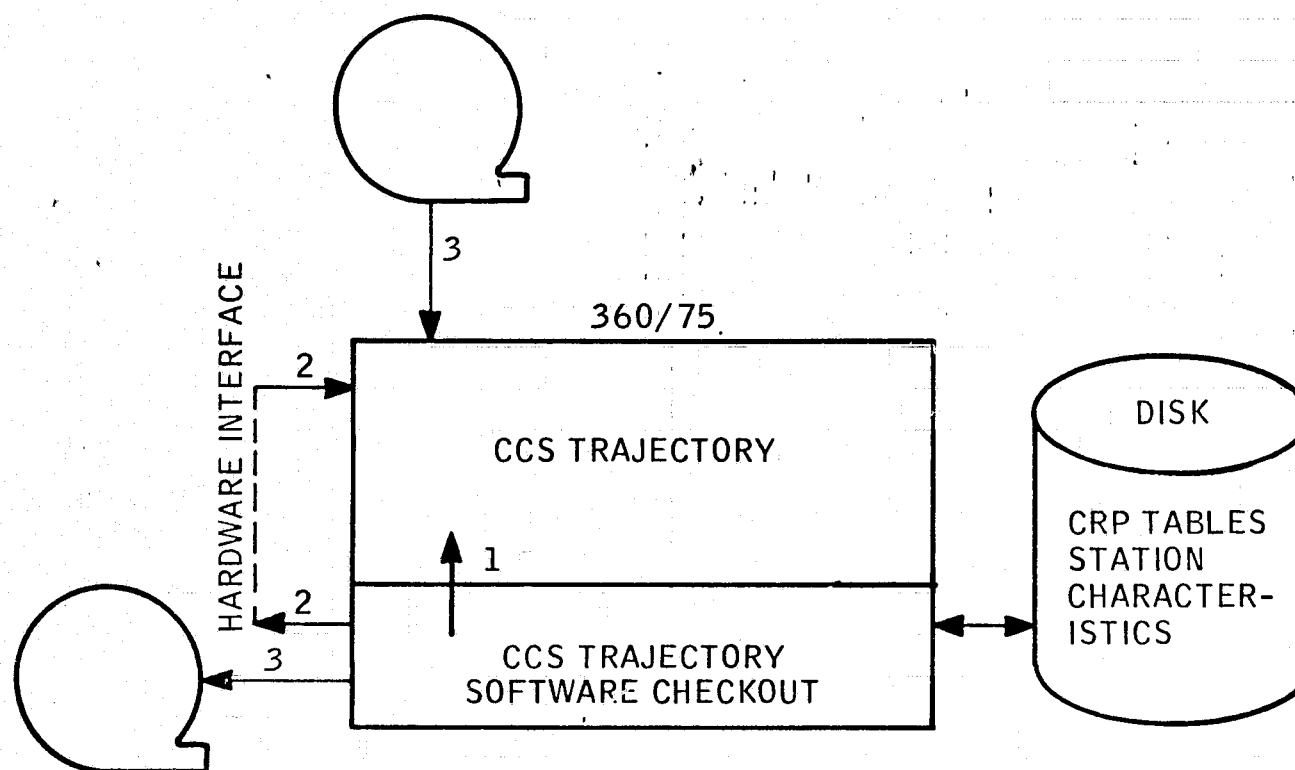
7.3.2.3 360/75 System Software. Testing/checkout of 360/75 OFTDS application software shall be accomplished using an online data generator as a scripted test data source. Performance evaluation of software shall be accomplished by use of autoscoring software. Where cost-effective online autoscoring shall be provided. Some offline and manual scoring shall be used; however, all test results must be available in nearreal-time.

The 360/75 checkout software shall be designed to support batch mode testing as well as scheduled (hands-on) testing. Reference figure 52 for 360/75 hardware configuration and data flow during software checkout. Checkout software for the 360/75 shall be designed to operate in a coresident mode.

Checkout and test software shall be designed and implemented in such a manner that selected subsets can be utilized for MCC validation testing. Scoring software shall be capable of operating in the open loop mode; i.e., it has the ability to synchronize with test sequence ID words in the input test data.

7.3.2.3.1 Data Generator. The 360/75 data generator shall be an application program in the 360/75. This program shall generate all test data necessary to test/checkout and validate 360/75 OFTDS support software (trajectory application). Additionally, the 360/75 shall provide the preprocessor scripting function for the SDPC TLM data generator. Test data for this support shall be transmitted via a CCT or disk.

The 360/75 data generator shall have the capability to build test data sets of TLM [including tracking (TRK) and command (CMD) response data] on CCT for the U418 Generalized Confidence Tape System (GCTS) to read/merge and output during specific test sequences during MCC end-to-end validation testing.



- 1 SINGLE JOBSTEP "BATCH MODE" - DATA GENERATION WITH CORE ROUTE TO APPLICATION.
- 2 MULTIJOBSTEP OR MULTICOMPUTER - DATA GENERATION WITH DATA TO HARDWARE INTERFACE AND LOOPED BACK TO APPLICATION. EXAMPLES OF TEST ARE SYSTEM PERFORMANCE TEST FOR EXAMINATION OF CPU AND CORE UTILIZATION BY APPLICATION.
- 3 PREPROCESS GENERATION OF TAPES TO BE USED IN STANDALONE APPLICATION TESTING.

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Figure 52 360/75 Hardware Configuration and Checkout Data Flow

7.3.2.3.2 Data Scorer. The data scorer shall perform limited autoscoring for 360/75 OFTDS support software (tracking data function). Scoring software shall be designed for both online and offline scoring and autoscoring where cost-effective. All scoring results, automatic or manual, shall be available in nearreal-time.

7.3.2.3.3 Functions Tested. The 360/75 software functions to be tested shall be those listed in section 6 published under separate cover by IBM.

7.3.2.3.4 360/75 OS. The 360/75 OS shall be tested to demonstrate and prove capability to meet all OFT support requirements. Testing/checkout methods are to be determined.

7.3.2.4 Configuration Requirements Program (CRP). Test and validation of CRP outputs represent a critical requirement. CRP outputs shall be used in building NIP, SDPC, 360/75, Simulation Process Control Unit (SPCU), etc. programs. Errors in CRP outputs can affect all system software and may be undetectable by software system test or software validation testing. This is due to the use of common CRP inputs by both online and checkout system software. The method to be used to test/checkout CRP output products is to be determined.

Functions of CRP requiring test/checkout and verification include those CRP functions listed in section 6 published under separate cover by IBM.

7.3.2.5 Terminal Control System (TCS). Test/checkout and verification software shall be provided for the TCS. Test/checkout software shall perform the following functions.

- Operate in the same computer with TCS as a coresident program

7.3.2.5 Terminal Control System (TCS). (Continued)

- Thoroughly test and validate all TCS software functions
- Be capable of supporting acceptance testing of TCS after software or hardware modification/reconfiguration
- Provide test results in nearreal-time
- Provide the capability to support dual computer testing when required.

TCS functions to be tested/verified by checkout software are listed in table 6.

7.4 Hardware Testing/Checkout and Verification. The following paragraphs shall define hardware checkout and testing requirements for Shuttle OFTDS. Data presented shall include hardware testing/checkout requirements for all MCC systems which comprise the OFTDS. Where appropriate, definitions shall be included to clarify requirements.

7.4.1 Acceptance Testing. Acceptance testing is defined as hardware device(s) testing prior to installation/integration into the MCC systems. Requirements include performance testing to equipment specification and may be accomplished by use of special or standard electronic/mechanical test equipment, special software programs, or a combination of both methods. Acceptance tests are formal, includes both witnessing and signoff by NASA, and are required prior to equipment or software integration into MCC support systems.

7.4.2 Qualification Testing. Qualification testing is defined as testing of hardware after installation/integration into the MCC systems. Testing at this level requires performance testing of hardware devices and/or related software programs to specifications which include subsystem or system performance, whichever

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TABLE 6

TCS FUNCTIONS FOR TESTING/VERIFICATION

FUNCTION TO BE TESTED ,	TEST OBJECTIVE
1. TERMINAL INPUTS <ul style="list-style-type: none"> ● SYNCHRONOUS - DATA RATES 2.4/4.8/9.6 KB/S ● ASYNCHRONOUS - DATA RATES 1/10/300 BAUD 	VALIDATE TERMINAL TO TCS I/F CONVENTIONS
2. HOST COMPUTER INTERFACE <ul style="list-style-type: none"> ● FUNCTION CODES ● SIGN-ON/SIGNOFF ● CONFIRMATIONS 	VALIDATE APPLICATION TO TCS I/F CONVENTIONS
3. TERMINAL/TCS/HOST COMPUTER INTERFACE <ul style="list-style-type: none"> ● DATA FLOW ● RESTART/ ● RECYCLE/ ● RECONFIGURATION 	VALIDATE MULTIPLE LDP ROUTING, TCS CONTROL, ETC.
4. ACCESS CONTROL	TEST ACCESS PROTOCOL
5. FOREGROUND/BACKGROUND DATA	TEST FOREGROUND/BACKGROUND DATA FORMATTING AND CAPABILITY
6. GRAPHIC DATA	TEST GRAPHICS CAPABILITY
7. AUTOMATIC DATA RESPONSE SIMULATION <ul style="list-style-type: none"> ● HOST COMPUTER TO TCS INTERFACE ● TCS CONTROLLER (SCC FORCED FUNCTIONS) 	TEST AUTOMATIC RESPONSES PROVIDED BY PROGRAM
8. SECURITY	TEST DATA ACCESS SECURITY FEATURES

7.4.2 Qualification Testing. (Continued)

is appropriate. Emphasis of qualification testing is on the equipment or software performance as an integral part of a subsystem or system. It is used to verify nondegradation of performance due to installation, interfacing, or environmental factors. Qualification tests are formal, require both witnessing and signoff by NASA, and are required prior to turnover of new or modified hardware/software to MCC user personnel.

7.4.3 Maintenance Testing. The following definitions of maintenance testing cover preventive maintenance, unit level testing, subsystem level testing, and system level testing.

- a. Preventive Maintenance Testing. Preventive maintenance testing and checkout is based on the requirement to test hardware for both electronic and mechanical performance in order to detect and remedy substandard conditions prior to actual equipment failure. Preventive maintenance must be performed continuously on a scheduled basis and, where applicable, include periodic replacement of parts which have a predictable service life. Preventive maintenance testing may require special purpose software and/or general purpose or unique test equipment. A comprehensive preventive maintenance program for MCC hardware is required in order to ensure mission support capability and to minimize equipment failure during prime support periods.
- b. Hardware Unit Level Testing. Hardware unit level testing is performance testing to a specification of a single functional unit such as a magnetic tape drive, line printer, or TV monitor. It may require a special software program such as original equipment manufacturer (OEM) line printer diagnostic software; however, many hardware devices are tested at the unit level by standard or special purpose hardware test equipment.

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7.4.3 Maintenance Testing. (Continued)

- c. Hardware Subsystem Level Testing. Hardware subsystem level testing requires hardware performance testing at the subsystem level. At this level testing does not verify each element of the subsystem to specifications. The objective is to measure collective performance as a subsystem; i.e., master instrumentation and timing equipment (MITE) subsystem, NOM subsystem, DTE, etc. Hardware testing at this level may require special software programs to support checkout and testing such as combined operational and readiness test (COHART) to checkout DTE hardware.
- d. Hardware System Level Testing. Hardware system level testing requires capability to verify and measure performance of all hardware within a system. System hardware operation is not normally verified by one overall test.

System operational integrity is established by execution of all hardware subsystem tests associated with the functional system and analysis of collective results of these tests. Results of testing must be available in real-time or nearreal-time, usually ≤ 10 minutes.

System level testing requires use of special purpose software such as COHART, CCATS Open Loop String Test (COST), or presimulation program (PRESIM). Example of hardware system level testing is CIM/DTE/DTV/DIST system test. Software to support this level of testing must be comprehensive and diagnostic in nature in order to facilitate both rapid fault isolation/repair as well as provide rapid verification of satisfactory operation.

Hardware system level tests may be used to requalify hardware systems after equipment modification.

7.4.4 Maintenance Testing and Checkout Support. Maintenance testing shall require built-in or portable smart test equipment in order to rapidly checkout and/or repair some categories of MCC equipment. For example, checkout and testing of the NIP system NCI shall require built-in test equipment to aid in maintenance testing.

Special software shall be required to checkout certain classifications of equipment within the MCC; i.e., unit level testing of hardware such as the AED equipment or unit level testing of the MBI controller.

Special hardware checkout programs shall be provided to support maintenance testing and acceptance/qualification testing of hardware systems. Four programs which shall be used for this purpose are as follows.

- 360/75 COHART
- SDPC Certification/Verification Program (new name is to be provided)
- TPC COST replacement (new name is to be provided)
- 1218 Maintenance Program Package.

7.4.4.1 360/75 COHART. Functional description to be provided.

7.4.4.2 SDPC Certification/Verification Program. Functional description to be provided.

7.4.4.3 TPC COST Replacement. Functional description to be provided.

7.4.4.4 1218 Maintenance Program Package. Functional description to be provided.

7.4.5 Computer Diagnostic Software. All vendor supplied computers and computer systems shall be provided with OEM diagnostic software. Diagnostic software shall be utilized to support performance testing/verification as well as preventive and corrective maintenance testing activities. Computer systems specifically covered in the following paragraphs are the TPC, SDPC, and 360/75 computers.

7.4.5.1 TPC Diagnostic Software. The Interdata 8/32 computer used to perform the TPC function shall be provided with the standard OEM diagnostic software package. Specific software tests shall include the following.

- Memory diagnostics
- Instruction set diagnostic
- Tests as required to cover all CPU elements
- Diagnostic tests for computer options
- Diagnostic tests for I/O options
- I/O interface diagnostics
- Diagnostic test routines for all peripheral devices delivered with the 8/32 systems.

TPC OEM diagnostic software shall execute in an offline mode and is not required to operate under control of the OS; the TPC diagnostic software package shall consist of a set of standalone software programs.

7.4.5.2 SDPC Diagnostic Software. The SDPC shall be provided with diagnostic programs necessary and sufficient to systematically check out and verify the operational capability of the SDPC hardware and to perform maintenance. As a minimum, the program shall verify the status and availability of all storage, status of the internal and external interfaces, and all error controls on data transfers within the SDPC. The diagnostics shall be divided into two categories, online and offline.

7.4.5.2.1 Online Diagnostics. Online diagnostics shall be available in the system library to be initiated by the computer operator. These diagnostics shall have the following characteristics.

- a. Operation under control of the system software
- b. Operation without preventing processing or I/O that is not dependent upon the failed system element; i.e., channel, control unit, or device
- c. Capability to perform a series of tests to isolate an error to a particular function within a system element
- d. Capability to continue testing functions when a single malfunction has been isolated
- e. Capability to perform single selected test
- f. Capability to perform repetitive device operations as required to support electronic and mechanical adjustments
- g. Availability of online diagnostics for test of all channels (exclusive of the display channels and without overlaying the system software), control, units, external interfaces, and peripheral devices.

7.4.5.2.2 Offline Diagnostics. Offline diagnostics shall be available to the SDPC for initiation by customer engineers. These diagnostics shall have the following characteristics.

- a. Operation in an offline computer
- b. Operation without system software support
- c. Capability to perform a series of tests and manual checks to isolate a failure to the replaceable/removable component level
- d. Capability to continue testing functions when a single malfunction has been isolated
- e. Capability to perform individual selected tests
- f. Capability to perform repetitive tests to support electronic and mechanical adjustments and stress equipments at their operating limits
- g. Availability of tests for checking the SDPC computer arithmetic and logic unit(s), arithmetic and logic control units, I/O channels, external SDPC interfaces, peripheral devices, and their control units.

7.4.5.3 360/75 Computer Diagnostic Software. To be provided.

7.4.6 MCC Hardware Maintenance/Acceptance Testing Functional Requirements. A matrix to be provided (reference paragraph 6.4.6.2) shall tabulate all MCC hardware functions requiring maintenance/acceptance/qualification testing support. Included is a list of categories of type of support required. Each function shall be identified as to categories of testing support which is applicable.

7.4.6.1 Definition of Maintenance/Acceptance Testing Categories. Definition of categories of maintenance/acceptance testing is to be provided.

7.4.6.2 MCC Hardware Function Matrix. Matrix of MCC hardware functions and applicable categories of test support required is to be provided.

7.4.7 Configuration. Several classes of equipment shall be configurable and shall require reconfiguration testing for each flight/mission. Reference table 7 for a summary of the requirement.

7.5 Validation Testing. Overall validation testing shall demonstrate and prove the capability of integrated systems to meet mission support requirements. Software and hardware capability shall be provided in order to support both internal and external validation tests. At a minimum, the following validation tests shall be supported.

- MCC End-to-End Validation Test (internal validation)
- Network Validation Test(s) (external validation).

Validation tests shall be supported by procedural use of subsets of software provided for software/hardware test and checkout to the extent practical. Validation testing shall sample test support functions to the extent required to assure that all mission

TABLE 7
OFT CONFIGURATION VERIFICATION REQUIREMENTS SUMMARY

EQUIPMENT SUBSYSTEM OR SYSTEM	SOFTWARE SUPPORTED CHECKOUT	MANUAL VERIFICATION
<u>VOICE LOOPS</u>		
• GENERIC		X
• CONFIGURABLE		X
<u>AED SYSTEM</u>		
• ANALOGS TO SCR, LBO	X	
• TLM EVENTS TO CONSOLES	X	
• TLM EVENTS TO SCR	X	
<u>CONSOLE CONFIGURATION - EVENT PANEL OVERLAYS</u>		X
<u>KEYBOARD CONFIGURATION (EXCEPT DRK)</u>		X
<u>SDD PATCHBOARDS</u>	X*	X

*NOT OPERATIONAL SOFTWARE

7.5 Validation Testing. (Continued)

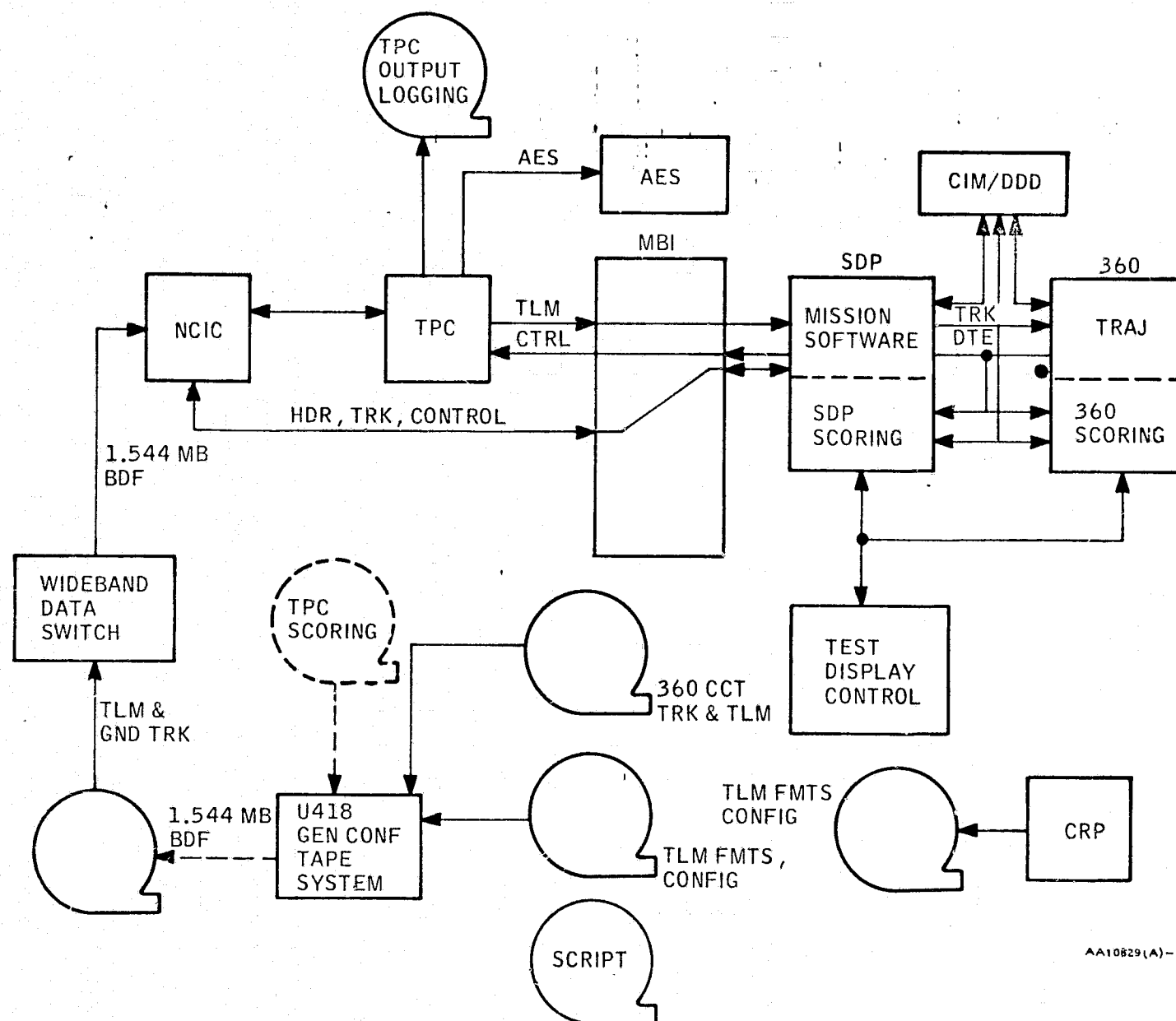
support requirements can be met. Testing must be rapid, conclusive, and designed to provide test scoring in nearreal-time. Validation test procedures shall be defined by MCC operations personnel and documented in validation test procedures manuals.

7.5.1 MCC End-to-End Validation Test. The MCC End-to-End Validation Test shall validate total MCC support capability and shall include testing of all system support elements in an integrated operating environment. Test data shall be in NASA communication network (NASCOM) 1.544 MB input format and all major systems in a mission support configuration (both hardware and software). Some temporary deviations in configuration shall be allowed during testing to facilitate scoring. Primary mission elements to be tested are processing of TLM, CMD, communications data, tracking data, and total system performance/interaction. Validation testing methods implemented shall be capable of providing full load test cases to the MCC for TLM, CMD, and tracking functions. Reference figure 53 for a block diagram of end-to-end validation testing.

7.5.1.1 Input Test Data. Test data shall be provided by a prerecorded WB tape generated on the U418 GCTS. TLM, TRK, and CMD data shall be scripted according to a planned test sequence and recorded on WB tape in the 1.544 MB NASCOM format.

7.5.1.1.1 Scripted Test Data. Scripted test data shall be provided to simulate up to four simultaneous GSTDN sites inputs. Dump/playback test data shall also be included in the test sequence.

7.5.1.1.2 Tracking Test Data. Tracking test data shall be provided to the U418 GCTS by the 360/75 data generator via CCT. The GCTS shall read tracking test data and merge tracking parameters into the test TLM output. Matching ground crack site messages shall be output from the GCTS at the appropriate message rate [10 samples per second (S/S)], 5 S/S, 1 sample/10 seconds per site.



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Figure 53 MCC End-to-End Validation Configuration

7.5.1.1.3 PCM TLM Scripted Test Data. PCM TLM scripted test data shall be available to support testing/checkout of up to 16 unique TLM formats. The format may contain eight different GPC downlists per DFT flight/mission. TLM data shall be generated by the U418 GCTS to simulate up to four GSTDN sites simultaneously. OI dump/playback and payload scripted test TLM shall also be generated by the U418 GCTS to simulate up to four GSTDN sites simultaneously. OI dump/playback and payload scripted test TLM shall also be generated by the U418 GCTS.

7.5.1.1.4 Pulse Code Modulation (PCM) TLM Scripted Values. PCM TLM scripted values used to test SDPC TLM application software shall be provided to the U418 GCTS by the 360/75 data generator via CCT. The U418 GCTS shall read the CCT and merge SDPC test values into the 1.544 MB output during scripted sequences which test SDPC software.

7.5.1.1.5 CMD TLM Responses. CMD TLM responses shall be generated by the 360/75 data generator and provided to the U418 GCTS via CCT. The GCTS shall read the CCT and merge the CMD data into the proper TLM data link slots at the proper time for scripted CMD test sequences. An option shall be available to generate CMD TLM responses directly on the GCTS by U418 GCTS script generation via 360/75 script tape.

7.5.1.2 Scoring. Scoring shall be provided by the software used for software test and checkout. This software shall be designed to provide nearreal-time results. For the MCC end-to-end validation test, all scoring shall be done at output devices; i.e., no intermediate scoring shall be performed.

7.5.1.2.1 TPC Scoring. TPC outputs shall be logged on CCT(s); CCT(s) shall be scored offline by U418 GCTS.

7.5.1.2.2 SDPC Scoring. All SDPC outputs shall be scored by the SDPC data scorer. Both online and offline scoring shall be utilized.

7.5.1.2.3 360/75 Scoring. The 360/75 outputs shall be scored by the 360/75 data scorer only where practical. Both online and offline scoring shall be utilized.

7.5.2 Network Validation Testing. Network validation testing shall provide comprehensive testing of the Shuttle mission support elements in the STDN/TDRSS sites and STDN system. Primary functions tested shall be network processing of TLM, CMD, communications data, and tracking data. Included in network validation testing shall be the requirement to demonstrate MCC capability to interface with and process network data. The network validation can be accomplished in one sequential test or four separate tests. Reference figure 54 for the network validation configuration diagram.

7.5.2.1 TLM Validation. TLM validation testing with GSTDN and TDRSS sites shall be accomplished by pushbutton of a scripted WB A/G TLM tape; the WB tape shall be generated on the U418 GCTS. after front-end processing of 1.544 MB input data, TPC outputs shall be logged on CCT and offline scored by U418 GCTS.

Since both GSTDN and TDRSS processing of TLM shall be fixed functions and not perturbed by changing software, TLM validation can be supported by a generic confidence tape. The test shall not be downlink (D/L) format dependent. The system shall be capable of supporting validation tests using either generic TLM confidence tapes or scripted D/L (format dependent) TLM confidence tapes.

TLM validation with TDRSS assumes that WB tape pushbutton capability at the TDRSS site shall be available. If not, the method to be used is to be determined.

7.5.2.2 CMD Validation. CMD validation testing with GSTDN sites shall be accomplished by manual control. Under manual control, the SDP shall transmit a predefined sequence of commands to



Figure 54 Network to MCC Validation

7.5.2.2 CMD Validation. (Continued)

GSTDN site(s). GSTDN site(s) shall send command history data to the SDP via the 1.544 MB GSTDN system. Manual scoring of site and CMD history data shall be used to evaluate CMD system performance. Site management CMD's shall be verified using the same procedure with manual scoring of test sequence.

7.5.2.2.1 CMD Validation with TDRSS. CMD validation with TDRSS is to be determined.

7.5.2.2.2 SMS Command Validation Test. The SMS Orbiter simulator can be used as an alternate or supplement to the CMD validation testing (reference paragraph 6.5.2.2.1). No special software shall be required by either the MCC or SMS.

7.5.2.3 Tracking Validation

- a. GSTDN. To be determined.
- b. TDRSS. To be determined.

7.5.2.4 Voice Communication Validation. For pre-TDRSS, communication validation tests with GSTDN sites shall be accomplished by utilization of standard OEM test equipment and standard voice circuit testing procedures. No special hardware or software shall be required.

Communications validation testing for TDRSS and GSTDN shall require verification of the DVS. The method used for validation testing is to be determined.

7.6 U418 GCTS. The U418 GCTS shall be used to generate scripted test data for use in testing/checkout and verification of the OFTDS. Test data shall be generated in the following formats.

- a. 1.544 MB NASCOM Format (BDF). This format shall contain the following data.
 - (1) Four sites of TLM, TRK (simultaneously)
 - (2) Orbiter and payload data
 - (3) CMD FLM responses
 - (4) Various A/G TLM formats/rates within 1.544 MB format
 - (5) Orbiter dump/playback
 - (6) Interleaved Orbiter A/G and dump TLM with payload data
- b. A/G Formats
 - (1) Orbiter (up to 16 D/L formats with 8 GPC down-lists per mission)
 - 192 kb
 - 128 kb
 - 96 kb
 - 64 kb
 - (2) Payloads
 - Interleaved with Orbiter
 - A/G format (to be determined)
 - Rates (up to 1.0 Mb/s)

7.6.1 GCTS WB Tapes. Test data generated by U418 GCTS shall be recorded on WB instrumentation tape for subsequent pushbutton into the OFTDS. GCTS data shall be used as input test stimuli in the following test categories.

- NIP/TPC software development through system test
- NIP/TPC acceptance testing
- NIP/SDPC (360/75) validation testing (both internal and network)

The U418 GCTS shall provide offline autoscoring of NIP/TPC outputs as follows when processing test data from the GCTS WB tapes.

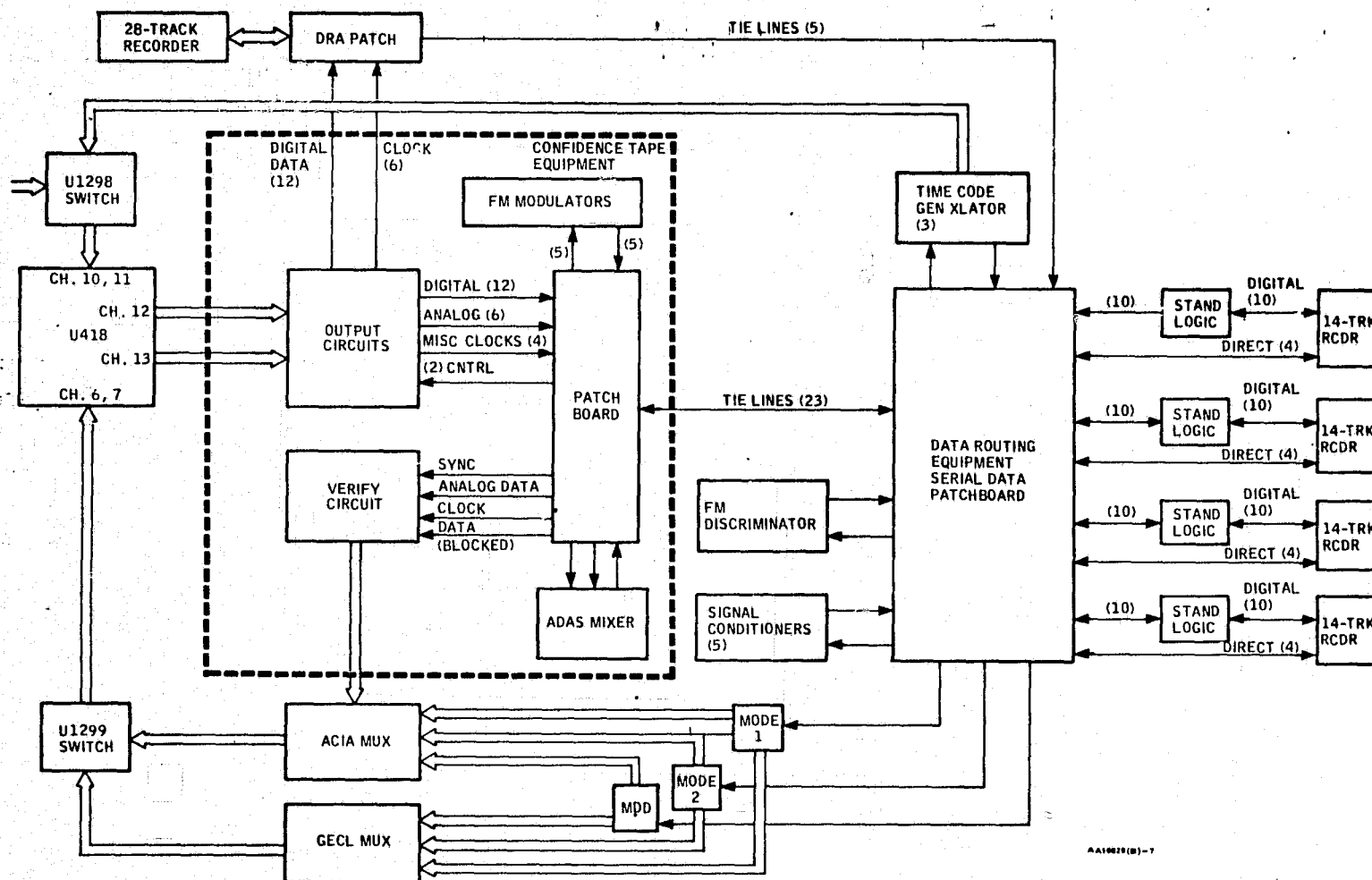
- IDSD CCT
- AES output (logged on CCT)
- SDPC input from TPC (logged on CCT).

7.6.2 GCTS Description. The following paragraphs shall provide a brief description of the GCTS. For a more detailed discussion of GCTS capability, refer to the following documents:

- SU-25827, *Confidence Tape Hardware Subsystem Performance Specification*
- *Generalized Confidence Tape System Users Guide*.

7.6.2.1 Hardware Description. The Confidence Tape Hardware Subsystem, with the U418 computer and the Generalized Confidence Tape Program, shall form the GCTS. The subsystem configuration is shown in figure 55.

The Confidence Tape Hardware Subsystem shall provide the capability to record and playback for verification telemetry tapes having pre-defined data values. These confidence tapes shall be utilized to certify performance of hardware and software in various processing systems utilizing telemetry tapes as data source; i.e., the OFT Data System and the LACIE.



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Figure 55 Confidence Tape Hardware Subsystem

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7.6.2.1.1 14-Track Confidence Tapes. The Confidence Tape Hardware Subsystem shall provide the capability to record and verify 14-track telemetry data tapes. The following minimum capabilities shall be provided.

- Record digital data in NRZ-L, Biphase-L or RZ format
- Up to 12 synchronous channels of digital PCM data for recording
- Up to six simultaneous channels of analog data for recording
- Data recording in the direct or frequency modulated mode
- IRIG-A, IRIG-B, and NASA 36-bit time code formats for recording
- Data in BDF with polynomial encoding (22 bits); block data size 2400/4800 bits
- Fixed-frequency clock outputs to record servo reference signals
- Demodulation of frequency modulated (FM) recordings
- Playbacks of two synchronous PCM data tracks and verification of data content using the U418 computer
- Playback of one analog data track and signal conversion to digital values for verification by the U418.

7.6.2.1.2 28-Track Confidence Tapes. The Confidence Tape Hardware Subsystem shall provide the capability to record and verify 28-track digital telemetry data tapes. The following minimum capabilities shall be provided.

- IRIG-A, IRIG-B, and NASA 36-bit time code formats for recording
- Up to 12 synchronous channels of digital PCM data for recording in Miller Code format

7.6.2.1.2 28-Track Confidence Tapes. (Continued)

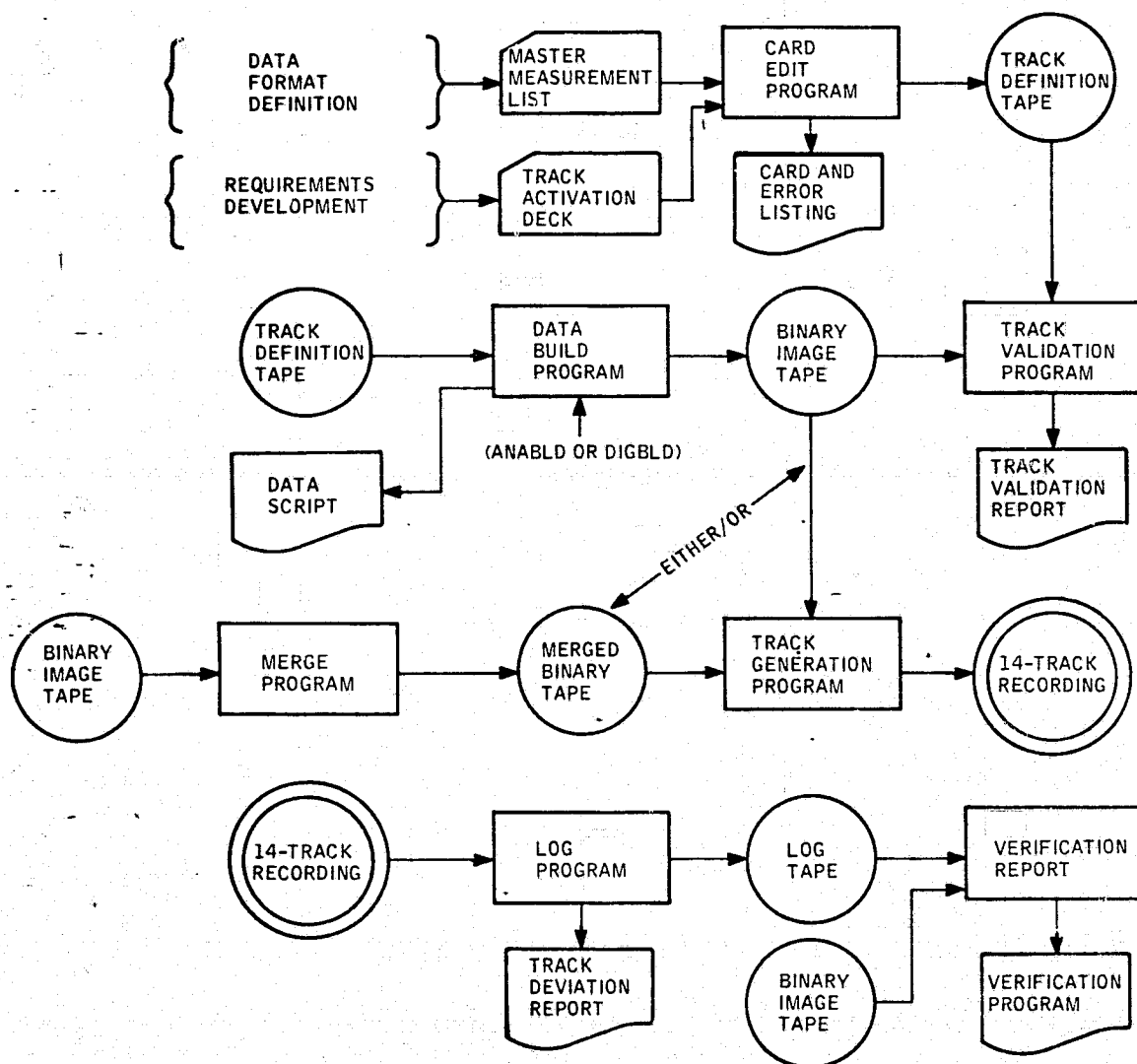
- Fixed-frequency clock outputs to record servo reference signals
- Synchronization of data recording with previously records data
- Playback of two synchronous Miller Code PCM data tracks and verify data content with the U418 computer.

7.6.2.1.3 Confidence Tape Equipment. The confidence tape equipment shall provide the output data interface between the U418 computer and the recording equipment. It shall also provide the capability to verify analog confidence tapes through a single-channel analog-to-digital conversion circuit.

The confidence tape equipment interface to the 14-track recorders shall consist of up to 12 synchronous digital output channels or up to six simultaneous analog output channels, -selectable at the confidence tape equipment patch panel for routing through the data routing equipment to the recorders.

7.6.2.2 Software Description. The GCTS (reference figure 56) shall be a series of interdependent program modules designed to generate an analog or digital multiple track tape which shall simulate the downlinks of spacecraft and/or aircraft. The GCTS shall be modularized in the following manner:

- a. Symbolic Update. Transcribe card images to tape.
- b. Edit. Validate input for the whole system.
- c. Digital Data Build (DIGBLD). Generate a 7-track CCT for input to subsequent modules for generation of a digital multiple track PCM tape.
- d. Analog Data Build (ALGBLD). Generate a 7-track CCT for input to subsequent modules for generation of a multiple analog tape.



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Figure 56 Generalized Confidence Tape System Flow

7.6.2.2 Software Description. (Continued)

- e. Track Validation (TRKVAL). TRKVAL shall duplicate the function of digital and analog data build modules and compare the results to previously generated analog or digital CCT.
- f. MERGE. Multiplex from 1 to 12 CCT's generated by digital and analog data build programs into one 9-track CCT for input to TRKGEN module.
- g. TRKGEN. Transfer 9-track multiplexed CCT data generated by the MERGE module via A/ECL to 14-track equipment.
- h. LOGDMX. Accept contents from A/ECL of one track of digital data or two tracks for analog (one being from the 14-track recorders and the other a sync track) and generate 7-track CCT to be used by the VERIFY module.
- i. VERIFY. Verification module shall read 7-track CCT output by the LOGDMX module and perform bit-by-bit comparison against analog or digital CCT generated by the DATBLD module.

The system limitations shall be as follows.

- a. A maximum of 12 tracks may be recorded simultaneously.
- b. All simultaneously recorded tracks must be at the same bit rate.
- c. Analog tracks recorded simultaneously with digital tracks must have a constant bit rate.
- d. A synchronization track must be built for each separately generated analog track for a set of analog tracks cut at the same time.

7.6.2.2 Software Description. (Continued)

- e. If a set of analog tracks are generated simultaneously, any one track cannot vary its scan line by time.
- f. The output of the STU (card image read) may not be used as an input to the DATBLD module. The user must go through the EDIT process prior to submitting the card images to DATBLD.

8. QUALITY ASSURANCE

8.1 General. Quality assurance provisions for equipment, subsystems, or systems manufactured by SISO shall be in accordance with NASA Publication NHB 5300.4(1D-1). Quality assurance provisions for equipment, subsystems, or systems procured as "off-the-shelf" or modified "off-the-shelf" shall be as specified in NASA Publications NHB 5300.4(1C) and NHB 5300.4(1D-1) respectively.

8.2 Workmanship. Workmanship shall be in accordance with Volume II of the SISO Standards, or SISO Quality Assurance approved equivalent vendor standards.

8.3 System Hardware Acceptance. Individual equipment acceptance shall be in accordance with an acceptance test procedure, qualification test procedure, or Test Preparation Sheet (TPS) prepared by SISO to demonstrate compliance of the equipment with the requirements of this specification. Testing of the OFTDS as an operational system shall be performed as a series of string tests conducted after suitable quality assurance inspection of hardware components comprising the string. Subsystem strings that are directly interactive will require concurrent testing, while other noninteractive strings will require individual testing as defined in the following paragraphs. Further testing details are contained in SISO Publications TN792 and TN788.

8.3.1 Interactive Testing. This testing is also referred to as string testing and shall consist of the following type tests.

- a. Analog Instrumentation. Analogs representing down-linked onboard parameters shall be simulated on magnetic tape and sent to analog meters and SCR channels in the DCS and Mission Evaluation Room Subsystem (MERS).
- b. Bilevel Instrumentation. Bilevel events shall be simulated and routed to event recorders and event indicators in the DCS. The Timing Subsystem shall provide the required event timing inputs.

8.3.1 Interactive Testing. (Continued)

- c. Plotboard Tests. Software generated simulated coordinate data shall be provided to the plotboards in the DCS.
- d. Timing. Timing signals shall be provided from magnetic tape and the Timing Subsystem for display in the MERS, DCS, and TVS.
- e. Video Tests. Video display of CRT characters and DTE video shall be provided by software generated data. Video shall be simulated by video tape recorders and shall test the RF distribution circuits. Hardcopy requests shall be tested.

8.3.2 Individual Testing. Testing of the Voice Communications Subsystem shall be tested at time of installation and in conjunction with recording facilities of the VCS.

Testing shall be provided by processing inputs from Building 5 simulated data. The Network Interface Processor (NIP) shall eventually provide an alternate testing input data source.

8.4 System Software Acceptance. The OFTDS shall be developed and tested prior to implementation of the NIP. Therefore, all testing shall be accomplished with simulated data from confidence tapes. The system tests shall be divided into areas compatible with the partitioning of the software. The tests shall provide testing of OFTDS real-time functions, tabulation, hardware, and telemetry network.

8.4.1 OFTDS Real-Time Testing. Software testing of the OFTDS real-time function shall require the Confidence Tape System. Reconfiguration tables for the current system configuration shall be compared with those for the previous system by the comparative software developed for system validation. Specific confidence tapes shall be prepared for DTE format testing, limit sensing, event processing, logic processing, event latching, navigation data, plotboard testing, and MDD tests.

8.4.2 Tabulation. Items that shall be tested include: data selection, EU conversion, listing options, and listing control language capabilities.

8.4.3 Hardware Testing. Individual hardware testing shall precede a total system test. Total system testing shall verify all interfaces.

8.4.4 Telemetry Network. The system testing for the telemetry network test software shall require the same confidence tape used to validate the OFTDS real-time functions. The data shall be logged and the log tape compared with the binary associated with the confidence tape.

9. PREPARATION FOR DELIVERY

9.1 Preparation and Packaging. Preparation and packaging of equipment items shall be in accordance with NASA Publication NHB 5300.4(1C). Preparation and packaging of systems or subsystems shall be in accordance with NASA Publication NHB 5300.4(1D-1).

9.2 Receipt at Destination. The subcontractor shall be responsible for assuring that equipment, upon receipt at destination, is free of damage and operative within the performance requirements of this specification.

9.3 Marking and Labeling for Shipment and Storage. Equipment item interior packages and exterior shipping containers shall be marked in accordance with NASA Publication NHB 5300.4(1C). Subsystem and system interior packages and exterior shipping containers shall be marked in accordance with NASA Publication NHB 5300.4(1D-1).

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Space Information Systems Operation

JSC-10013

APPENDIX A

LIST OF ACRONYMS AND ABBREVIATIONS

APPENDIX A

LIST OF ACRONYMS AND ABBREVIATIONS

ACIA	APCU/CCIA Interface Adapter
ADAS	Auxiliary Data Annotation Set; Auxiliary Data Analysis Station
ADEG	Auxiliary Display Equipment Group
AED	Analog Event Drivers
AES	Analog Event Subsystem
AFS	Atomic Frequency Standard
A/G	Air-to-Ground
AGC	Automatic Gain Control
AIRP	Aircraft Instrumentation Research Program
ALCIM	ALSEP Computer Input Multiplexer
ALGBLD	Analog Data Build
ALSEP	Apollo Lunar Science Experiment Package
ALT	Approach and Landing Test
A/N	Alphanumeric
ANSI	American National Standards Institute
AOS	Acquisition of Signal
AP	Array Processor
APCU	Apollo Process Control Unit
ASCII	American Standard Code for Information Interchange
ASP	Attached Support Processing
ASTP	Apollo Soyuz Test Program
AVSM	Auxiliary Video Switch Matrix
AWG	American Wire Gauge
AWS	Air Weather Service
BCD	Binary-Coded Decimal
BDF	Blocked Data Format
BFCs	Backup Flight Control System
BITE	Built-In Test Equipment
bpi	Bits per Inch
BRCL	Background Request Control Logic
BSA	Byte-Serial Adapter
bp/s	Bits per Second

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LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

CAJU	Control Area Junction Unit
CAP	Command Acceptance Pattern
CASRS	Countdown and Status Receiver System
CAST	Countdown and Status Transmitter
CAW	Cluster Allocation Word
CC	Configuration and Controller
CCA	Channel-to-Channer Adapter
CCATS	Command, Control, and Telemetry System
CCF	Central Computing Facility
CCH	Channel Check Handler
CCIA	Console-to-Computer Interface Adapter
C/CIM	Command/Computer Input Multiplexer
CCMU	Computer Controller Multiplexer Unit
CCRF	Consolidated Communications Recording Facility
CCS	Command and Control System
CCSS	Console Communication Subsystem
CCT	Computer-Compatible Tape
CCTCF	Communication Circuit Technical Control Facility
CDF	Combined Distribution Frame
CEC	Camera Exposure Command
CER	Command Execute Request
CIM	Computer Input Multiplexer
CIS	Communication Interface System
CLM	Computer Language Memory
CLS	Communications Line Switch
CLT	Communications Line Terminal
CMD	Command
COHART	Combined Operational Hardware and Readiness Testing
COM	Computer Output Microfilm
COST	CCATS Open Loop String Test
CP	Communication Processor
CPU	Central Processing Unit

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

CRP	Configuration Requirements Processor
CRT	Cathode Ray Tube
CSC	Command System Controller
CT	Communication Terminal
CTC	Cable Termination Cabinet
CTMC	Communication Terminal Multiplexer Control
CVT	Communication Vector Table
D/A	Digital-to-Analog
DAC	Digital-to-Analog Converter
DACIU	DAC Interface Unit
DACU	DAC Unit
dB	Decibel
D/C	Display/Control
DCC	Data Computation Complex
DCCU	Digital Television Equipment Cluster Control Unit
DCDU	Display Cluster Diagnostic Unit
DCS	Display and Control System
DCU	Data Control Unit
DCU-R	Data Control Unit Receiver
DCU-T	Data Control Unit Transmitter
DDD	Digital Display Driver
DDDIU	Digital Display Driver Interface Unit
DDP	Dump Data Processor
DDPS	Dump Data Processing Subsystem
DDDSDD	DDD Subchannel Data Distributor
DDS	Discrete Display Subsystem
DEC	Digital Electronics Corporation
DEM0D	Demodulator
DEU	Display Electronics Unit
DFI	Development Flight Instrumentation
DIGBLD	Digital Data Build
D/L	Downlink

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

DLM	Display Language Memory
DLSM	Data Link Summary Message
DMA	Direct Memory Access
DOMSAT	Domestic Satellite
DOS	Disk Operating System
DPCC	Data Processing Computer Complex
DPDT	Double Pole Trouble Switch
DPL	Data Processing Logic
DRA	Data Reformatter Assembler
DRAFT	Data Retrieval and Formatting Techniques
DRK	Display Request Keyboard
DSAD	Data Systems and Analysis Directorate
DSC	Dynamic Standby Computer
DSCIM	Display Select Computer Input Multiplexer
DTE	Digital Television Equipment
DTEIC	DTE Interface Cabinet
D/TV	Digital Television
DTS	Digital Television Subsystem
DVS	Digital Voice Subsystem
EBCDIC	Extended Binary Coded Decimal Interchange Code
ECS	Extended Core Storage
EIA	Electronic Industries Association
EOAP	Earth Observations Aircraft Program
EOS	Enhanced Operating System
ER	Earth Resources
EREP	Earth Resources Experiment Package
ERIPS	Earth Resources Interactive Processing System
ERTIU	Event Recorder Timing Interface Unit
ERTS	Earth Resources Technology Satellite
ESTL	Electronic Systems Test Lab
ESW	Equipment Status Word
ETR	Eastern Test Range

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

EU	Engineering Unit
FACS	Facility Control Subsystem
FAP	Functional Assignment Panel
FC	Flight Controller
FCD	Flight Control Division
FCR	Flight Control Room
FDM	Frequency Division Multiplexer
FEID	Flight Equipment Interface Device
FLIH	First Level Interrupt Handler
FM	Frequency Modulation
FOD	Flight Operations Directorate
FODA	FOD Auditorium
FS	Field Sequential
FSK	Frequency Shift Keyed
FWTS	4-Way Transfer Switch
GDSD	Ground Data Systems Division
GMT	Greenwich Mean Time
GCTS	Generalized Confidence Tape System
GECL	Gemini Exchange Control Logic
GET	Ground-Elapsed Time
GPC	General-Purpose Computer
GPT	General-Purpose Time
GSFC	Goddard Space Flight Center
GSSC	Ground Support Simulation Computer
GSTDN	Ground Satellite Tracking Data Network
HBR	High Bit Rate
HDR	High Data Rate
HSD	High-Speed Data
HSP	High-Speed Printer
IA	Interface Adapter
IBM	International Business Machines

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

ICC	Intercomputer Coupler
ICU	Interface Control Unit
ID	Identification
IDA	Intermediate Data Array
IDF	Intermediate Distribution Frame
IDSD	Institutional Data Systems Division
IEODCS	Interactive Earth Observation Display/Control System
I/F	Interface
IIM	Input Interface Module
IME	Interprocessor Message Exchanger
IMS	Information Management System
INCO	Instrumentation and Communication Officer
I/O	Input/Output
IOP	Input/Output Processor
IP	Impact Predictor
IPL	Initialization Program Loading
IPS	Inches per Second
IRIG	Interrange Instrumentation Group
ISI	Internal Specified Index
IUS	Interim Upper Stage
JSC	Lyndon B. Johnson Space Center
kb	Kilobit
kb/s	Kilobits per Second
KSC	John F. Kennedy Space Center
LACIE	Large Area Crop Inventory Experiment
LAR	Load Address Register
LBR	Low Bit Rate
LCS	Large Core Storage
LCT	Launch Countdown Time
LDSS	LACIE Data System Supervisor
LED	Light Emitting Diode

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

LOS	Loss of Signal
LPM	Line per Minute
LS	Low Speed
LSB	Least Significant Bit
LSR	Line Scan Rate
MAC	Memory Assignment Control
MAM	Memory Access Multiplexer
MBI	Multibus Interface
Mb/s	Megabits per Second
MC	Multiplexer Channel
MCC	Mission Control Center
MCDS	Multifunction CRT Display System
MDF	Main Distribution Frame
MED	Manual Entry Device
MERS	Mission Evaluation Room Subsystem
MDCU	Magnetic Drum Control Unit
MDSU	Magnetic Drum Storage Unit
MEDICS	Medical Information Computer System
MET	Mission Elapsed Time
MIPS	Million Instructions per Second
MITE	Master Instrumentation and Timing Equipment
MITS	Master Instrumentation Timing System
MM	Mass Memory
MMDB	Master Measurement Data Base
M&O	Maintenance and Operations
MOC	Mission Operations Computer
MOCR	Mission Operations Control Room
MOD	Modulator
MODEM	Modulator/Demodulator
MOPR	Mission Operations Planning Room
MOPS	Mission Operations Planning System
MOW	Mission Operations Wing
MPS	Main Propulsion System

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

MPSR	Multipurpose Support Room
MS	Multiplexer Subchannel
MSB	Most Significant Bit
MSC	Manned Spacecraft Center (now JSC)
MSFN	Manned Spaceflight Network
MSK	Manual Selection Keyboard
MSS	Multispectral Scanner
MSTU	Master Synchronization and Timing Unit
MTCU	Magnetic Tape Control Unit
MTU	Magnetic Tape Unit
MUX	Multiplexer
MVT	Multiprogramming with Variable Number of Tasks
NASA	National Aeronautics and Space Administration
NASCOM	NASA Communications Network
NBS	National Bureau of Standards
NCF	NASCOM Formatter
NCIC	Network Communications Interface Common
NCI	Network Communications Interface
NESR	Natural Environment Support Room
NI	Nucleus Initialization Program
NIP	Network Interface Processor
nmi	Nautical Miles
NOAA	National Oceanic and Atmospheric Administration
NOM	Network Output Multiplexer
NRZ	Non-Return-to-Zero
NTSC	National Television Standards Committee
NWS	National Weather Service
OD	Orbiter Downlink
OEM	Original Equipment Manufacturer
OFT	Orbital Flight Test
OFTDS	OFT Data System

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

OI	Operational Instrumentation
OMS	Orbital Maneuvering System
OM	Operations Manager
OPS	Operations
OS	Operating System
OSW	Operations Support Wing
PA	Public Address
PABX	Private Automatic Branch Exchange
PB	Parallel Binary
PBI	Pushbutton Indicator
PCD	Pulse-Coded-Decimal
PCL	Priority Control Logic
PCM	Pulse Code Modulation
PDA	Pulse Distribution Amplifier
PDSDD	Plotting Display Subchannel Data Distributor
PET	Phase Elapsed Time
PFC	Production Film Converter
PHO	Philco Houston Operations (now SISO)
PM	Phase Modulation
POC	Processor-Oriented Circuits
POCC	Payload Operation Control Center
PPS	Production Processor System
PRESIM	Presimulation Program
p/s	Pulses per Second
PSK	Phase-Shift-Keyed
PSW	Program Status Word
RCS	Reaction Control System
RF	Radio Frequency
RGB	Red, Green, Blue
RJE	Remote Job Entry
RM	Refresh Memory

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

ROD	Raw Orbiter Downlink
R/S	Remote Site
RSB	Reproduction Services Branch (MSD, JSC)
RTA	Real-Time Accumulator
RTC	Real-Time Command
RTCC	Real-Time Computer Complex
RTCS	Real-Time Computer System
RTOS	Real-Time Operating System
RTR	Ready-to-Receive
RTT	Ready-to-Transmit
RZ	Return-to-Zero
SAIL	Shuttle Avionics Integration Lab
SAS	Send Allocation Status
SC	Selector Channel
SCA	Shuttle Carrier Aircraft
SCATS	Simulation, Checkout, and Training System
SCR	Stripchart Recorder
SCU	System Configuration Unit
SDD	Subchannel Data Distributor
SDL	Software Development Lab
SDPC	Shuttle Data Processing Complex
SDPS	Shuttle Data Processing System
SDTC	Serial-Decimal Time Converter
SEF	Systems Engineering Facility
SGDS	Shuttle Ground Data System
SGMT	Simulated Greenwich Mean Time
SIC	Simulated Input Control
SIM	Simulations
SIP	Selectover-in-Progress
SLIH	Second Level Interrupt Handler
SOD	Shuttle Operations Director; Site-Originated Data

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

SOW	Support Operations Wing
SMEK	Summary Message Enable Keyboard
SMS	Shuttle Mission Simulator
SPC	Stored Program Command
SPCU	Simulation Process Control Unit
SPIMS	Shuttle Program Information Management System
SPL	Speech Power Level
SPP	Special Purpose Processor
SR	Support Room
SRF	System Restart Facility
SSC	Selector Subchannel
SSD	Site Selector Data
SSEU	System Selector Extension Unit
S/S	Samples per Second
SSU	System Selector Unit
STDI	Simulation Trajectory Data Interface
STDN	Space Tracking and Data Network
STS	Space Transportation System
SVC	Service Call
TAEM	Terminal Area Energy Management
TASS	Terminal Application Support System
TBD	To be determined
TBS	To be supplied
TCB	Task Control Block
TCCE	Terminal Communication Control Element
TCS	Terminal Control Subsystem
TCSM	TV Channel Status Module
TDD	Timing Display Driver
TDRSS	Tracking Data Relay Satellite System
TED	Telemetry Event Driver
TELCO	Telephone Company

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

THRIFT	Telemetry History Report in Formatted Tabulations
T/L	Talk/Listen
T/L-M	Talk/Listen-Monitor
TLM	Telemetry
TPC	Telemetry Processing Complex
TPS	Test Preparation Sheet
TRK	Tracking
TRKVAL	Track Validation
TS	Timing Subsystem
TSO	Time-Share Option
TTL	Test Tone Level
TTY	Teletype
TV	Television
TVSS	Television Subsystem
UAR	Unload Address Register
USB	Unified S-Band
USNO	U.S. Naval Observatory
UTC	Universal Coordinated Time
V ac	Volts, Alternating Current
CVO	Voltage Controlled Oscillator
VCS	Voice Communication Subsystem
VDA	Video Distribution Amplifier
V dc	Volts, Direct Current
VESM	Video Engineers Switching Matrix
VF	Voice Frequency
VFTG	Voice Frequency Telegraph
VOX	Voice-Operated Relay
V rms	Volts, Root-Mean-Square
VSM	Video Switching Matrix
VSMBM	VSM Buffer Multiplexer
VSS	Video Scanner Switch
VSSM	Video Scanner Switching Matrix